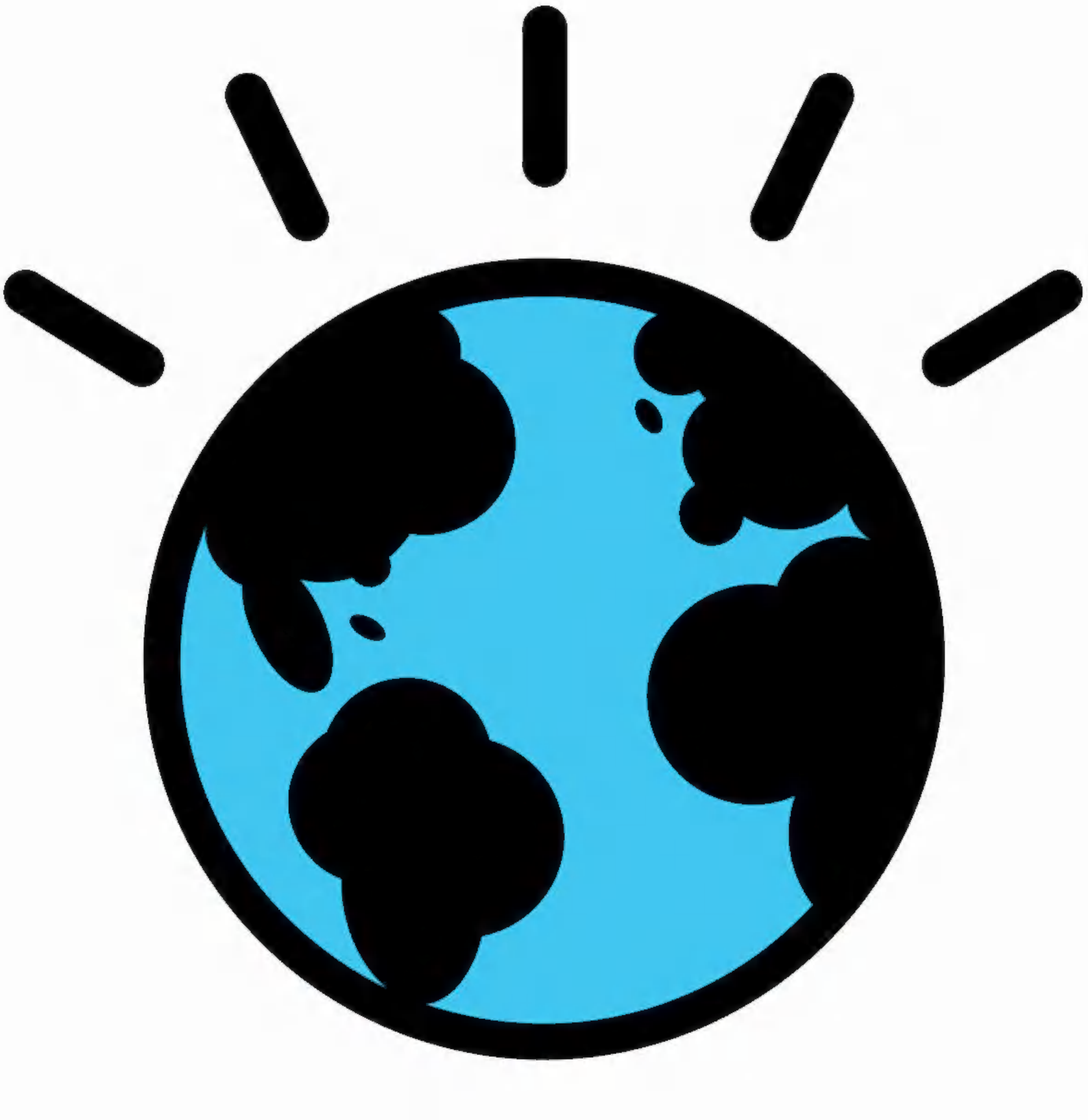
NATIONALGEOGRAPHIC.COM/MAGAZINE | SEPTEMBER 2009

NATIONAL GEOGRAPHIC

Before New York

REDISCOVERING THE WILDERNESS OF 1609

THINK



Conversations for a Smarter Planet

A mandate for change is a mandate for smart.

The world is ready for change – that much is clear.

For leaders of all kinds, this moment presents a rare opportunity. Our planet is not just getting smaller and flatter. It is also becoming smarter. And that means we have the potential to change the way the world literally works.

Computational power is now being put into things we wouldn't recognize as computers – cars, appliances, cameras, roadways…even pharmaceuticals and livestock. We are interconnecting all of this through the Internet, which has come of age. And we are applying powerful new systems and sophisticated analytics to turn oceans of data into insight, knowledge and intelligence.

Consider the changes already under way.

Smart traffic systems are helping to reduce gridlock by 20%, cutting pollution and increasing ridership on public transit.

Smart food systems based on RFID technology embedded into supply chains are monitoring meat, poultry and other items from the farm to the super-market shelf.

Smart healthcare systems are helping to lower the cost of therapy by as much as 90%.

Police departments are correlating street-level information from myriad observations and devices to identify crime patterns – helping prevent crime, rather than simply punishing it.

The list is long, and the transformation is just beginning. Its benefits will be reaped not only by large enterprises, but also by mid-sized and small companies – the engines of economic growth everywhere – and by individuals and communities around the world.

Imagine how a smarter planet will transform *all* the things we seek. The ways we pursue economic growth, societal progress, environmental sustainability and cures for disease. The way we interact with each other and with the world.

The opportunity is before us, and the moment will not last forever. Will we seize it? As we look to stimulate our economies and rebuild our infrastructure, will we simply repair what's broken? Or will we prepare for a smarter future?

Join us at **ibm.com**/smarterplanet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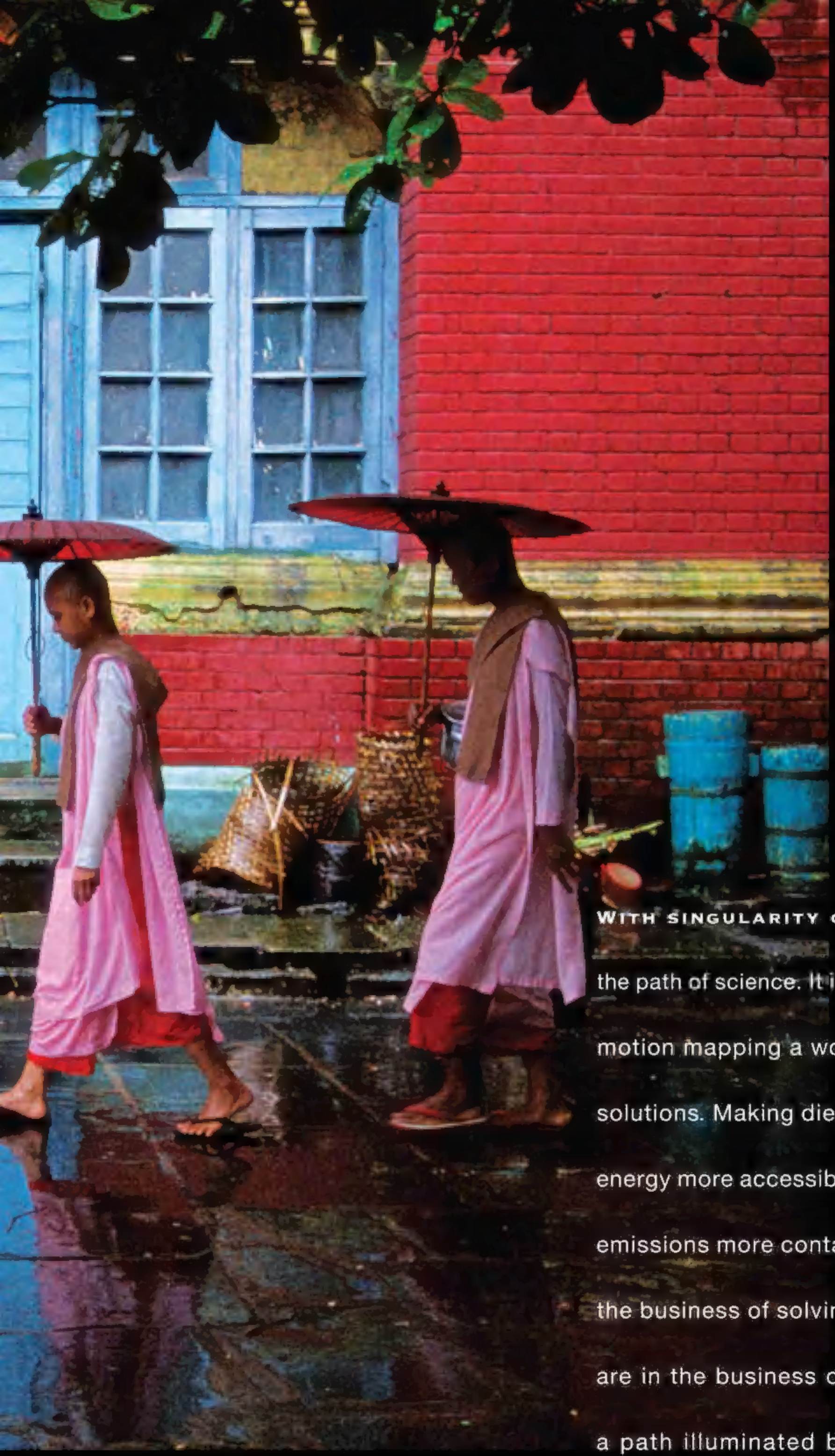

WITH SINGULARITY OF PURPOSE. That is the path of science. It is in constant forward motion mapping a world of problems and solutions. Making diesel run cleaner, solar energy more accessible and carbon emissions more containable. Science is in the business of solving problems. And we are in the business of science. Following a path illuminated by the values of the Human Element.

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NATIONAL GEOGRAPHIC

SEPTEMBER 2009 · VOL. 216 · NO. 3

CHRISTIAN ZIEGLER (ALL)

The 25,000 species of orchids dazzle with diversity. Story on page 100.

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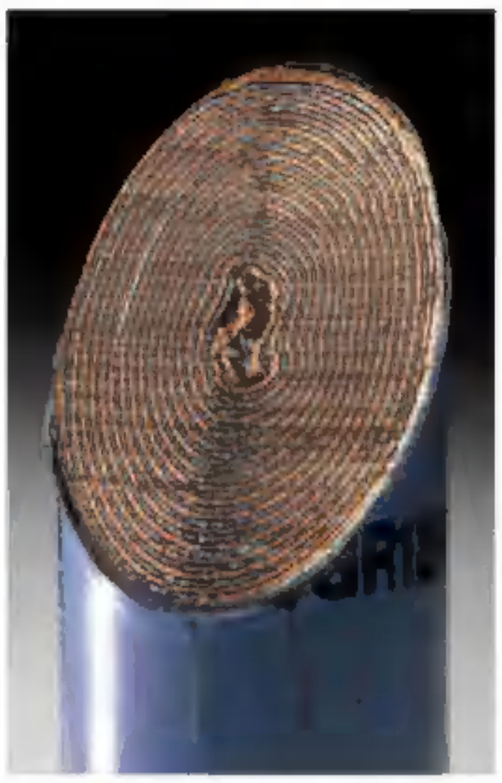
NATIONAL GEOGRAPHIC

DEPARTMENTS



ngm.com

Before New York
Our map of New York City won't guide you to Carnegie Hall. Instead, click on modern landmarks to see streams, swamps, and other features from 400 years ago.

On the Cover
Two views show lower Manhattan then (1609, computer-generated image) and now (2009, aerial shot).
CGI by Markley Boyer
Photo by Robert Clark

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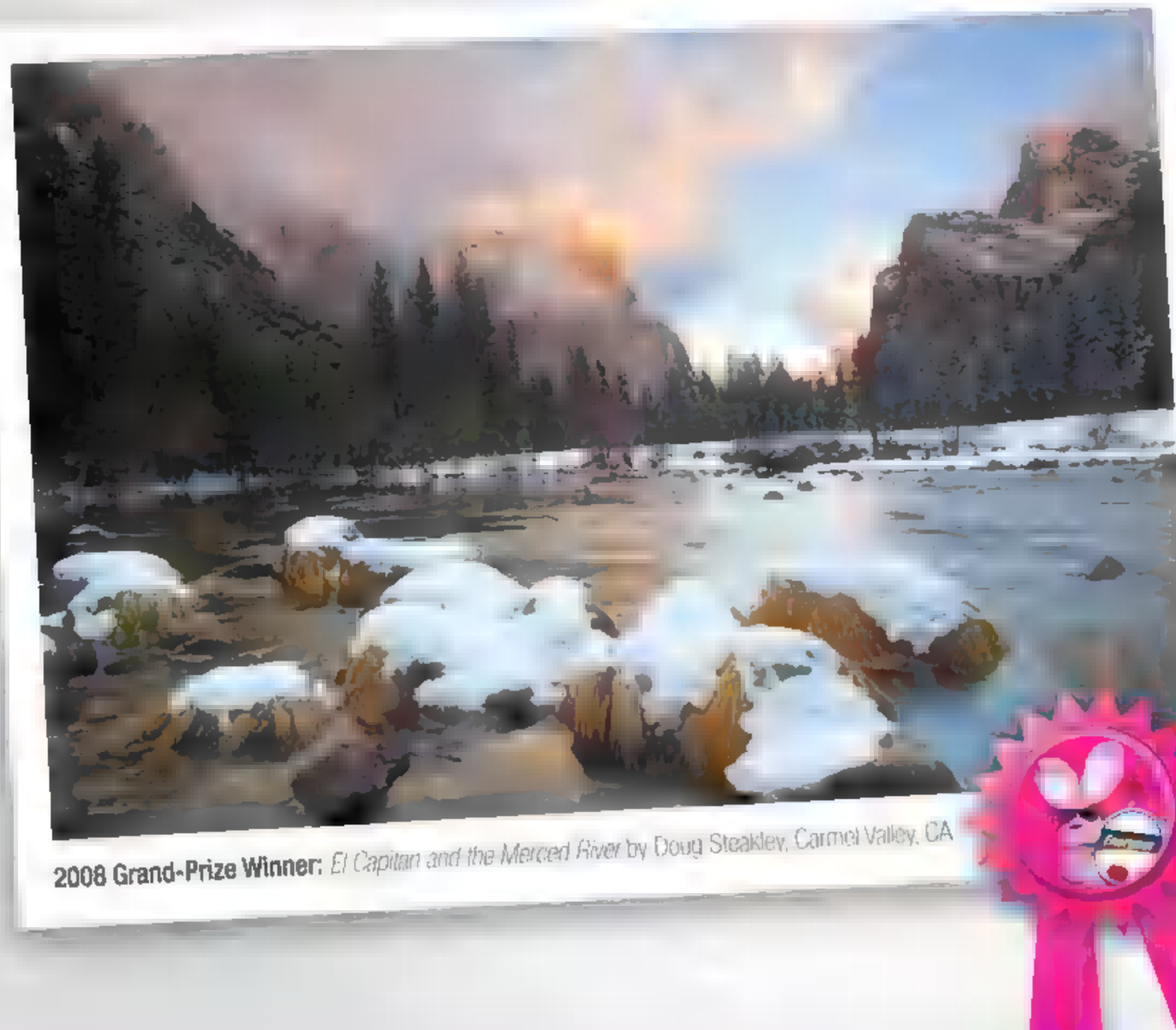
CAST YOUR VOTE in the 2nd Annual ENERGIZER ULTIMATE PHOTO CONTEST



2008 Grand-Prize Winner: *El Capitan and the Merced River* by Doug Steakley, Carmel Valley, CA

Choosing an "ultimate" photograph from the thousands of amazing images submitted in this year's contest is not easy. So we're asking for your help. ***Now through SEPTEMBER 15, 2009, you can help us narrow the field by casting your vote for your favorite finalist in each of the six entry categories.*** Look for this year's winners on *nationalgeographic.com* in October and in the December issue of *National Geographic* magazine.

Vote today at nationalgeographic.com/ultimate

View a Gallery of Stunning Entries
From This Year's Contest

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To get the best shot, you need the best equipment. So wherever your ultimate photography adventures take you, be sure you have the dependable power of *Energizer® Ultimate Lithium*. These AA and AAA batteries last up to 8x longer* in digital cameras. And with the ability to withstand extreme conditions, ■ 15-year storage life, and leak-resistant construction, *Energizer® Ultimate Lithium* lets you take your mind off your batteries and focus on capturing that once-in-a-lifetime shot.

*Vs. Energizer® MAX®. Results vary by camera.

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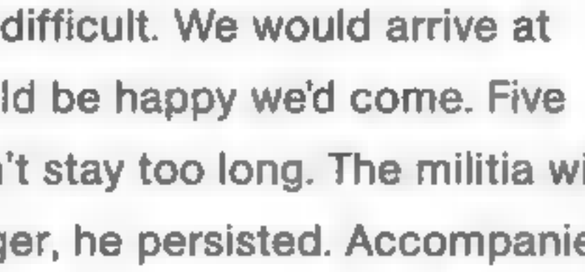
EDITOR'S NOTE

It may seem like madness for a photographer to repeatedly risk his life in one of the most dangerous places on Earth, but that is exactly what Pascal Maitre did on five visits to Somalia. (He photographed the street scene above in Mogadishu.) Without a stable government since 1991, the country is arguably the scene of Africa's worst humanitarian crisis. It's one of the deadliest places a journalist can be. Pascal began photographing there in 2002 and established the relationships that made this month's "Shattered Somalia" story possible. In 2008 he returned with writer Robert Draper.

"When I first came to Somalia, it was terrible; we felt it couldn't be more down," Pascal told me. "I'd return, and it was even darker and more difficult. We would arrive at a feeding center. People would be happy we'd come. Five minutes later they'd say: 'Don't stay too long. The militia will shoot you.'" Despite the danger, he persisted. Accompanied by bodyguards, he'd spend time in a Mogadishu hospital where patients were so beaten down they were beyond tears. "Their eyes were dry. They were no longer crying. They have seen so much. There is no sense of normal life."

To bear witness to such suffering requires the highest measure of compassion and conviction. That is why Pascal Maitre kept going back. "Somalis came up to me every day and asked, 'Why has the world abandoned us?'" he says. "I'm hoping my pictures can help just a little bit."



NATIONAL GEOGRAPHIC

Inspiring people to care about the planet

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PHOTO: PASCAL MAITRE

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AMBIEN CR is the only form of Ambien that is FDA approved to help you fall asleep and stay asleep:

The first layer dissolves quickly to help you fall asleep fast, while the second dissolves slowly to help you stay asleep*—so you wake up less frequently and fall back to sleep faster. Wake up ready for your day** with 2-layer AMBIEN CR.

There is no generic form of AMBIEN CR, so ask your prescriber or pharmacist for AMBIEN CR by name.

* Proven effective for up to 7 hours in clinical studies.

** Individual results may vary

For special savings and a 7-Night free trial of AMBIEN CR visit: CRFree7Day.com or call 1.877.827.1767.

IMPORTANT SAFETY INFORMATION

AMBIEN CR is indicated to help you fall asleep and/or stay asleep.

AMBIEN is indicated for short-term treatment to help you fall asleep.

AMBIEN and AMBIEN CR are treatment options you and your doctor can consider along with lifestyle changes. When taking either of them, don't drive or operate machinery. Plan to devote 7 to 8 hours to sleep before being active. Sleepwalking, and eating or driving while not fully awake, with memory loss for the event, as well as abnormal behaviors such as being more outgoing or aggressive than normal, confusion, agitation, and hallucinations may occur. Don't take it with alcohol as it may increase these behaviors. In patients with depression, worsening of depression, including risk of suicide may occur. If you experience any of these behaviors contact your doctor immediately.

Allergic reactions such as shortness of breath, swelling of your tongue or throat, may occur and in rare cases may be fatal. If you have an allergic reaction while using AMBIEN or AMBIEN CR, contact your doctor immediately. Side effects of AMBIEN CR may include next-day drowsiness, dizziness and headache. There is a low occurrence of side effects associated with the short-term use of AMBIEN. The most commonly observed side effects in controlled clinical trials were drowsiness, dizziness, and diarrhea.

AMBIEN is taken for 7 to 10 days–or longer as advised by your provider. AMBIEN CR can be taken as long as your doctor recommends. AMBIEN and AMBIEN CR have some risk of dependency. They are non-narcotic.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088.

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A GOOD NIGHT'S SLEEP FROM START TO FINISH.™

Please see important medication guide on adjoining page.

MEDICATION GUIDE

AMBIEN CR® (ām'bē-ən see ahr) **C-IV**

(*zolpidem tartrate extended-release tablets*)

Read the Medication Guide that comes with AMBIEN CR before you start taking it and each time you get a refill. There may be new information. This Medication Guide does not take the place of talking to your doctor about your medical condition or treatment.

What is the most important information I should know about AMBIEN CR?

After taking AMBIEN CR, you may get up out of bed while not being fully awake and do an activity that you do not know you are doing. The next morning, you may not remember that you did anything during the night. You have a higher chance for doing these activities if you drink alcohol or take other medicines that make you sleepy with AMBIEN CR. Reported activities include:

- driving a car ("sleep-driving")
- making and eating food
- talking on the phone
- having sex
- sleep-walking

Call your doctor right away if you find out that you have done any of the above activities after taking AMBIEN CR.

Important:

1. Take AMBIEN CR exactly as prescribed

- Do not take more AMBIEN CR than prescribed.
- Take AMBIEN CR right before you get in bed, not sooner.

2. Do not take AMBIEN CR if you:

- drink alcohol
- take other medicines that can make you sleepy. Talk to your doctor about all of your medicines. Your doctor will tell you if you can take AMBIEN CR with your other medicines.
- cannot get a full night's sleep

What is AMBIEN CR?

AMBIEN CR is a sedative-hypnotic (sleep) medicine. AMBIEN CR is used in adults for the treatment of a sleep problem called insomnia. Symptoms of insomnia include:

- trouble falling asleep
- waking up often during the night

AMBIEN CR is not for children.

AMBIEN CR is a federally controlled substance (C-IV) because it can be abused or lead to dependence. Keep AMBIEN CR in a safe place to prevent misuse and abuse. Selling or giving away AMBIEN CR may harm others, and is against the law. Tell your doctor if you have ever abused or have been dependent on alcohol, prescription medicines or street drugs.

Who should not take AMBIEN CR?

Do not take AMBIEN CR if you are allergic to anything in it. See the end of this Medication Guide for a complete list of ingredients in AMBIEN CR.

AMBIEN CR may not be right for you. Before starting AMBIEN CR, tell your doctor about all of your health conditions, including if you:

- have a history of depression, mental illness, or suicidal thoughts
- have a history of drug or alcohol abuse or addiction
- have kidney or liver disease
- have a lung disease or breathing problems
- are pregnant, planning to become pregnant, or breastfeeding

Tell your doctor about all of the medicines you take including prescription and nonprescription medicines, vitamins and herbal supplements. Medicines can interact with each other, sometimes causing serious side effects. **Do not take AMBIEN CR with other medicines that can make you sleepy.**

Know the medicines you take. Keep a list of your medicines with you to show your doctor and pharmacist each time you get a new medicine.

How should I take AMBIEN CR?

- Take AMBIEN CR exactly as prescribed. Do not take more AMBIEN CR than prescribed for you.
- **Take AMBIEN CR right before you get into bed.**
- **Do not take AMBIEN CR unless you are able to stay in bed a full night (7-8 hours) before you must be active again.**
- Swallow AMBIEN CR Tablets whole. Do not chew or break the tablets. Tell your doctor if you cannot swallow tablets whole.
- For faster sleep onset, AMBIEN CR should NOT be taken with or immediately after a meal.
- Call your doctor if your insomnia worsens or is not better within 7 to 10 days. This may mean that there is another condition causing your sleep problems.
- If you take too much AMBIEN CR or overdose, call your doctor or poison control center right away, or get emergency treatment.

What are the possible side effects of AMBIEN CR?

Serious side effects of AMBIEN CR include:

- **getting out of bed while not being fully awake and do an activity that you do not know you are doing.** (See "What is the most important information I should know about AMBIEN CR?)
- **abnormal thoughts and behavior.** Symptoms include more outgoing or aggressive behavior than normal, confusion, agitation, hallucinations, worsening of depression, and suicidal thoughts or actions.
- **memory loss**
- **anxiety**
- **severe allergic reactions.** Symptoms include swelling of the tongue or throat, trouble breathing, and nausea and vomiting. Get emergency medical help if you get these symptoms after taking AMBIEN CR.

Call your doctor right away if you have any of the above side effects or any other side effects that worry you while using AMBIEN CR.

The most common side effects of AMBIEN CR are:

- headache
- sleepiness
- dizziness
- You may still feel drowsy the next day after taking AMBIEN CR. **Do not drive or do other dangerous activities after taking AMBIEN CR until you feel fully awake.**

After you stop taking a sleep medicine, you may have symptoms for 1 to 2 days such as: trouble sleeping, nausea, flushing, lightheadedness, uncontrolled crying, vomiting, stomach cramps, panic attack, nervousness, and stomach area pain.

These are not all the side effects of AMBIEN CR. Ask your doctor or pharmacist for more information.

Call your doctor for medical advice about side effects. You may report side effects to FDA at 1–800–FDA–1088.

How should I store AMBIEN CR?

- Store AMBIEN CR at room temperature, 59° to 77°F (15° to 25° C).
- **Keep AMBIEN CR and all medicines out of reach of children.**

General Information about AMBIEN CR

- Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide.
- Do not use AMBIEN CR for a condition for which it was not prescribed.
- Do not share AMBIEN CR with other people, even if you think they have the same symptoms that you have. It may harm them and it is against the law.

This Medication Guide summarizes the most important information about AMBIEN CR. If you would like more information, talk with your doctor. You can ask your doctor or pharmacist for information about AMBIEN CR that is written for healthcare professionals. For more information about AMBIEN CR, call 1-800-633-1610 or visit www.ambiencr.com.

What are the ingredients in AMBIEN CR?

Active Ingredient: Zolpidem tartrate

Inactive Ingredients: The 6.25 mg tablets contain: colloidal silicon dioxide, hypromellose, lactose monohydrate, magnesium stearate, microcrystalline cellulose, polyethylene glycol, potassium bitartrate, red ferric oxide, sodium starch glycolate, and titanium dioxide. The 12.5 mg tablets contain: colloidal silicon dioxide, FD&C Blue #2, hypromellose, lactose monohydrate, magnesium stearate, microcrystalline cellulose, polyethylene glycol, potassium bitartrate, sodium starch glycolate, titanium dioxide, and yellow ferric oxide.

Rx Only

This Medication Guide has been approved by the U.S. Food and Drug Administration.

sanofi-aventis U.S. LLC
Bridgewater, NJ 08807
January 2008a
AMBCR-JAN08a-M-Ab

MEDICATION GUIDE
AMBIEN® (ām'bē-ən) Tablets C-IV
(zolpidem tartrate)

Read the Medication Guide that comes with AMBIEN before you start taking it and each time you get a refill. There may be new information. This Medication Guide does not take the place of talking to your doctor about your medical condition or treatment.

What is the most important information I should know about AMBIEN?

After taking AMBIEN, you may get up out of bed while not being fully awake and do an activity that you do not know you are doing. The next morning, you may not remember that you did anything during the night. You have a higher chance for doing these activities if you drink alcohol or take other medicines that make you sleepy with AMBIEN. Reported activities include:

- driving a car ("sleep-driving")
- making and eating food
- talking on the phone
- having sex
- sleep-walking

Call your doctor right away if you find out that you have done any of the above activities after taking AMBIEN.

Important:

1. Take AMBIEN exactly as prescribed

- Do not take more AMBIEN than prescribed.
- Take AMBIEN right before you get in bed, not sooner.

2. Do not take AMBIEN if you:

- drink alcohol
- take other medicines that can make you sleepy. Talk to your doctor about all of your medicines. Your doctor will tell you if you can take AMBIEN with your other medicines.
- cannot get a full night's sleep

What is AMBIEN?

AMBIEN is a sedative-hypnotic (sleep) medicine. AMBIEN is used in adults for the short-term treatment of a sleep problem called insomnia. Symptoms of insomnia include:

- trouble falling asleep

AMBIEN is not for children.

AMBIEN is a federally controlled substance (C-IV) because it can be abused or lead to dependence. Keep AMBIEN in a safe place to prevent misuse and abuse. Selling or giving away AMBIEN may harm others, and is against the law. Tell your doctor if you have ever abused or have been dependent on alcohol, prescription medicines or street drugs.

Who should not take AMBIEN?

Do not take AMBIEN if you are allergic to anything in it.
See the end of this Medication Guide for a complete list of ingredients in AMBIEN.

AMBIEN may not be right for you. Before starting AMBIEN, tell your doctor about all of your health conditions, including if you:

- have a history of depression, mental illness, or suicidal thoughts
- have a history of drug or alcohol abuse or addiction
- have kidney or liver disease
- have a lung disease or breathing problems
- are pregnant, planning to become pregnant, or breastfeeding

Tell your doctor about all of the medicines you take including prescription and nonprescription medicines, vitamins and herbal supplements. Medicines can interact with each other, sometimes causing serious side effects. **Do not take AMBIEN with other medicines that can make you sleepy.**

Know the medicines you take. Keep a list of your medicines with you to show your doctor and pharmacist each time you get a new medicine.

How should I take AMBIEN?

- Take AMBIEN exactly as prescribed. Do not take more AMBIEN than prescribed for you.
- **Take AMBIEN right before you get into bed.**
- **Do not take AMBIEN unless you are able to stay in bed a full night (7-8 hours) before you must be active again.**
- For faster sleep onset, AMBIEN should NOT be taken with or immediately after a meal.
- Call your doctor if your insomnia worsens or is not better within 7 to 10 days. This may mean that there is another condition causing your sleep problem.
- If you take too much AMBIEN or overdose, call your doctor or poison control center right away, or get emergency treatment.

What are the possible side effects of AMBIEN?
Serious side effects of AMBIEN include:

- **getting out of bed while not being fully awake and do an activity that you do not know you are doing.** (See "What is the most important information I should know about AMBIEN?)
- **abnormal thoughts and behavior.** Symptoms include more outgoing or aggressive behavior than normal, confusion, agitation, hallucinations, worsening of depression, and suicidal thoughts or actions.
- **memory loss**
- **anxiety**
- **severe allergic reactions.** Symptoms include swelling of the tongue or throat, trouble breathing, and nausea and vomiting. Get emergency medical help if you get these symptoms after taking AMBIEN.

Call your doctor right away if you have any of the above side effects or any other side effects that worry you while using AMBIEN.

The most common side effects of AMBIEN are:

- drowsiness
- dizziness
- diarrhea
- "drugged feelings"
- You may still feel drowsy the next day after taking AMBIEN. **Do not drive or do other dangerous activities after taking AMBIEN until you feel fully awake.**

After you stop taking a sleep medicine, you may have symptoms for 1 to 2 days such as: trouble sleeping, nausea, flushing, lightheadedness, uncontrolled crying, vomiting, stomach cramps, panic attack, nervousness, and stomach area pain.

These are not all the side effects of AMBIEN. Ask your doctor or pharmacist for more information.

Call your doctor for medical advice about side effects. You may report side effects to FDA at 1–800–FDA–1088.

How should I store AMBIEN?

- Store AMBIEN at room temperature, 68° to 77°F (20° to 25°C).
- **Keep AMBIEN and all medicines out of reach of children.**

General Information about AMBIEN

- Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide.
- Do not use AMBIEN for a condition for which it was not prescribed.
- Do not share AMBIEN with other people, even if you think they have the same symptoms that you have. It may harm them and it is against the law.

This Medication Guide summarizes the most important information about AMBIEN. If you would like more information, talk with your doctor. You can ask your doctor or pharmacist for information about AMBIEN that is written for healthcare professionals. For more information about AMBIEN, call 1-800-633-1610.

What are the ingredients in AMBIEN?

Active Ingredient: Zolpidem tartrate

Inactive Ingredients: hydroxypropyl methylcellulose, lactose, magnesium stearate, micro-crystalline cellulose, polyethylene glycol, sodium starch glycolate, and titanium dioxide. In addition, the 5 mg tablet contains FD&C Red No. 40, iron oxide colorant, and polysorbate 80.

Rx Only

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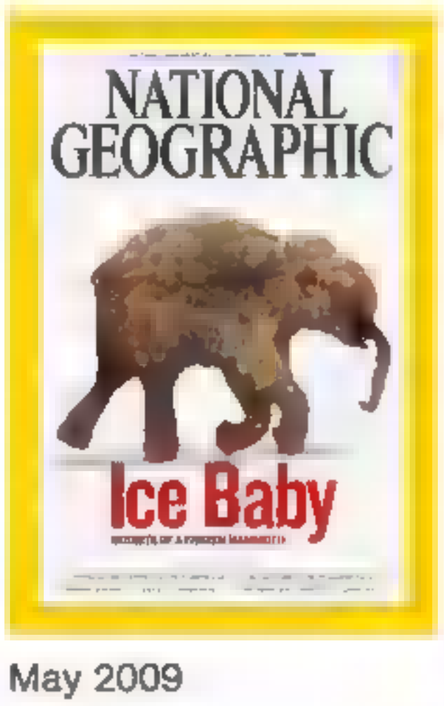
LETTERS



May 2009

Ice Baby

The article about the discovery and study of the baby mammoth left me weeping. I can only hope that after all the tests have been done and her time in the laboratory is finished, she will be given the respect she is due and not stuffed away in some freezer, forgotten—or worse, paraded around from museum to museum as a freak of history. She is ■ treasure and should be treated as such.

KELLEY SNOWDEN
Overton, Texas

Recipe for a Resurrection

With so many human beings dying daily and so many animals near extinction, why would anyone want to spend the time, money, and research to have a mammoth walk again? Let mankind try to save what is living now.

LESLIE WHITE
Santa Barbara, California

The potential consequences of resurrecting extinct species range from disruption of modern ecosystems and species to exploitation to global indifference to the plight of currently endangered species. To be sure, there are potential benefits as well, but the pros and cons should be explored by all before we take such giant leaps, lest we find ourselves in a crisis. Author Tom Mueller's piece, which focuses more on the scientific feasibility of cloning mammoths than the far more difficult question posed on the magazine's cover ("Should we clone extinct animals?"), presents only the views of DNA scientists to the exclusion of ethicists, ecologists, and other relevant experts. It does not do the subject the justice it deserves.

COREY SALSBERG
Needham, Massachusetts

Arctic Landgrab

Reading about the Arctic oil rush is like finding a vast outdoor institution for the terminally deluded. The fossil-fuel people act as though the global warming crisis were a quaint story from some other planet. They remind me of what Joseph Conrad said about a character in *Typhoon:* "Omens were as nothing to him, and he was unable to discover the message of a prophesy till the fulfillment had brought it home to his very door." Given what the worst-case scenarios now look like, there is no sane business case for further oil exploration anywhere on Earth.

LES CARTER
Rossland, British Columbia

Once we get past all the posturing, nationalism, and chest thumping, the major concern over this extremely fragile environment has to be who sets the environmental rules. While most nations are aware of the impact that development can have on the ecosystem, the Russians are oblivious to their carelessness. Combined with their record of sloppy engineering, that should give us all cause for concern. One need only reference Chernobyl and the *Kursk* submarine incident as examples. However, we in North America also have a less than enviable track record. Before any further intrusion into the Arctic, could we not call a conference of all participating nations and agree to strict environmental standards? Let us pray that stewardship of the Arctic will be a result of leadership by good example rather than by force.

DON MACMILLAN
Oakville, Ontario

Your article mentioned that Barrow, Alaska, is the northernmost town in North America. Aren't Sachs Harbour, Resolute, and Grise Fiord, Canada, all located farther north than Barrow? I've seen these places described as hamlets, but I don't know if they are officially towns, villages, or something else. Is this just an issue of semantics?

GABRIEL WALSH
New York, New York

The communities mentioned are so small they are not considered towns. Sachs Harbour and Grise Fiord, for example, have populations of only about a hundred residents each.

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LETTERS

Ancient Mariner

Your article will be an informative teaching tool in our forthcoming tropical field-biology course visit to Trinidad, which includes a night beach trip to see leatherbacks nesting. I spent many nights in the 1980s on "turtle walks" along the southeastern coast of India. We collected olive ridley eggs and incubated them in a protective hatchery. Since our hatchery was farther from the beach than the actual nests, we now realize that we may have done more harm than good, because incubation temperatures influence the sex ratio of hatchlings. Warmer temperatures produce more females! Leatherbacks may be more vulnerable, because they seem sensitive to even slight deviations from the temperature at which equal numbers of both sexes are produced.

RAGUPATHY KANNAN
Professor of Biology
University of Arkansas–Fort Smith
Fort Smith, Arkansas

Searching for Shangri-La

When I backpacked through Zhongdian in 2005, it was a fairly forgettable city still in the process of being rebuilt for tourism. Shortly after arriving, my companions and I were walking down an alley with "traditional" wooden buildings going up when a carpenter and his apprentice beckoned us to their workshop for some tea. As the carpenter tossed wood scraps into a small stove, I asked him with my basic Chinese about the name change to Shangri-La and the buildings going up. His response was easy to understand: "It's all fake." Everyone we met still called the city Zhongdian, and the tourist center of town ended up being the least interesting part of it all. We found out as we continued our trip that western Yunnan is full of many more fascinating places lacking kitschy names from English novels.

GABE GOSSETT
Madison, Wisconsin

Up on the Roof

As I sit overlooking so many flat roofs in central London, I realize the untapped potential. I feel that we have so far to go, but suddenly attainability seems possible, owing to

the commercial benefits. Imagine the increased amenity to our living spaces as we could grow apples, pears, honey, and rice on our roofs whilst we enjoy a glass of our favorite tipple—and the fantastic skylines of our cities. Absolutely fabulous!

EDDIE SMITH
London, England

Using a two-page photograph of Chicago's City Hall roof garden to launch your article is a perfect example of image over substance. Here is a city of nearly three million people that has never had—and is still far from—a working recycling program. A city that still favors cars over public transit. The second irony in the photo is the slanting-glass Thompson Center building shown to the left of City Hall. When it opened for business, the sun made it so hot that employees set beach umbrellas over their desks until the air-conditioning was upgraded and turned to high.

BILL WADE
Chicago, Illinois

Flat roofs in humid climates have always been a bad idea. But there are simpler ways to accomplish the goals: permeable pavers, regular sloping roofs that are insulated enough to hold a blanket of snow in winter, rain barrels and cisterns, fewer lawns, and more areas of native-plant ecosystems. And no-tech "green roofs" continue to be practicable. In Midewin National Tallgrass Prairie the remaining ammo bunkers of the former Joliet arsenal have their sloping sides of reinforced concrete covered with soil and local native grasses, just like the earth lodges of the tribes of the upper Missouri River that Lewis and Clark visited.

JEAN SMILINGCOYOTE
Chicago, Illinois

I would think it counterproductive to grow much of anything on roofs that are ten-plus stories high. Imagine the difficulties of getting water, fertilizer, et cetera up to the plants—plus the air pollution.

PHILLIP TUTTLE
Carthage, Illinois

The Great Wall

As Seen By Michael Yamashita

Through breathtaking photography and his own fascinating historical insight, Michael Yamashita will take you on a journey to China's Great Wall, as seen through his eyes.

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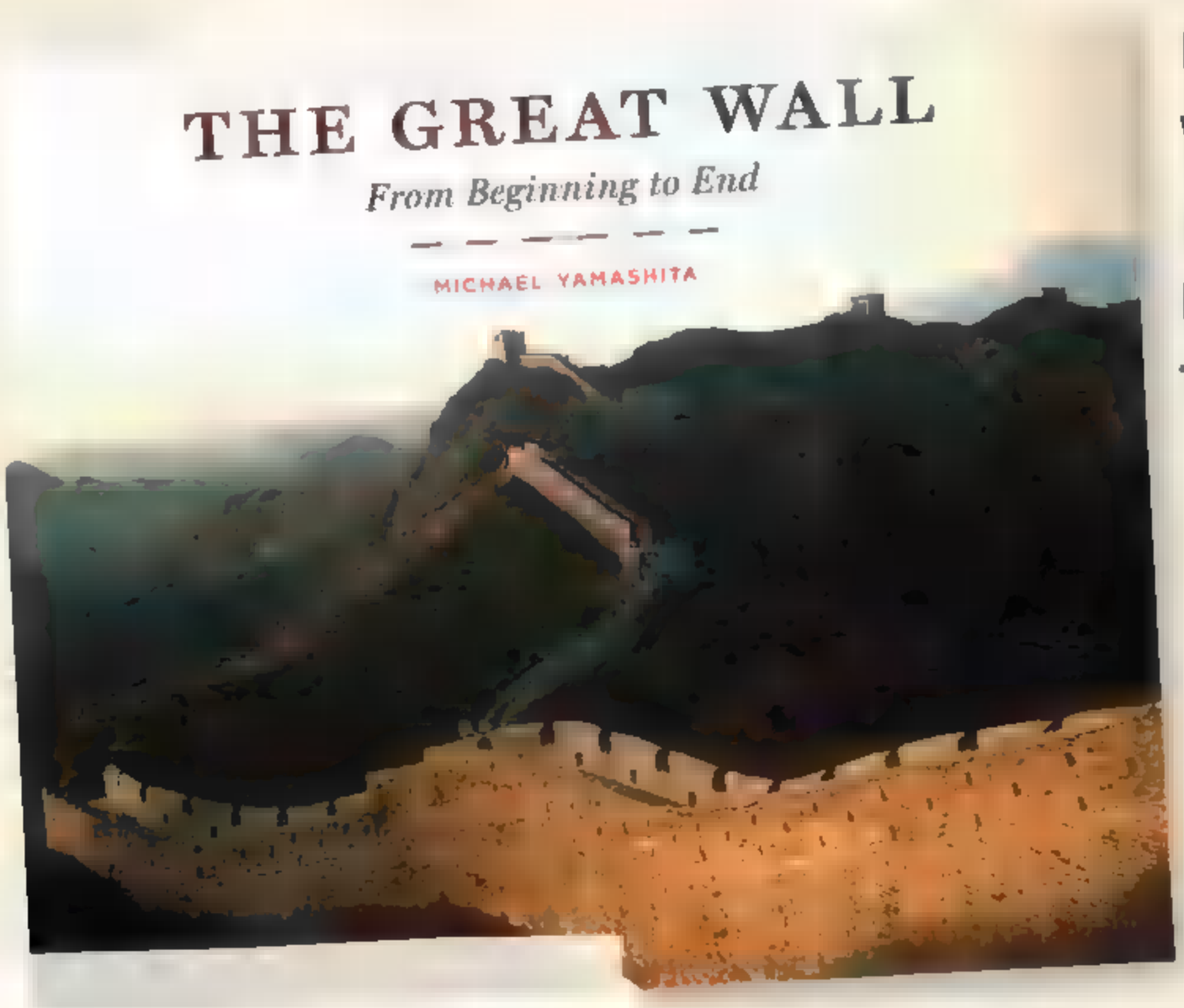

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Light and Shadow Whether it's ■ glowing critter or ■ rain-slick cityscape, interplay of light and dark can illuminate and inspire. Some call it chiaroscuro. We call it the makings of ■ great shot. Have you taken a picture like that? Send it to us. Every month, this page features two photos: one chosen by our editors, one chosen by our readers via online voting. For guidelines, a submission form, and more information, go to *ngm.com/yourshot*.

EDITORS' CHOICE

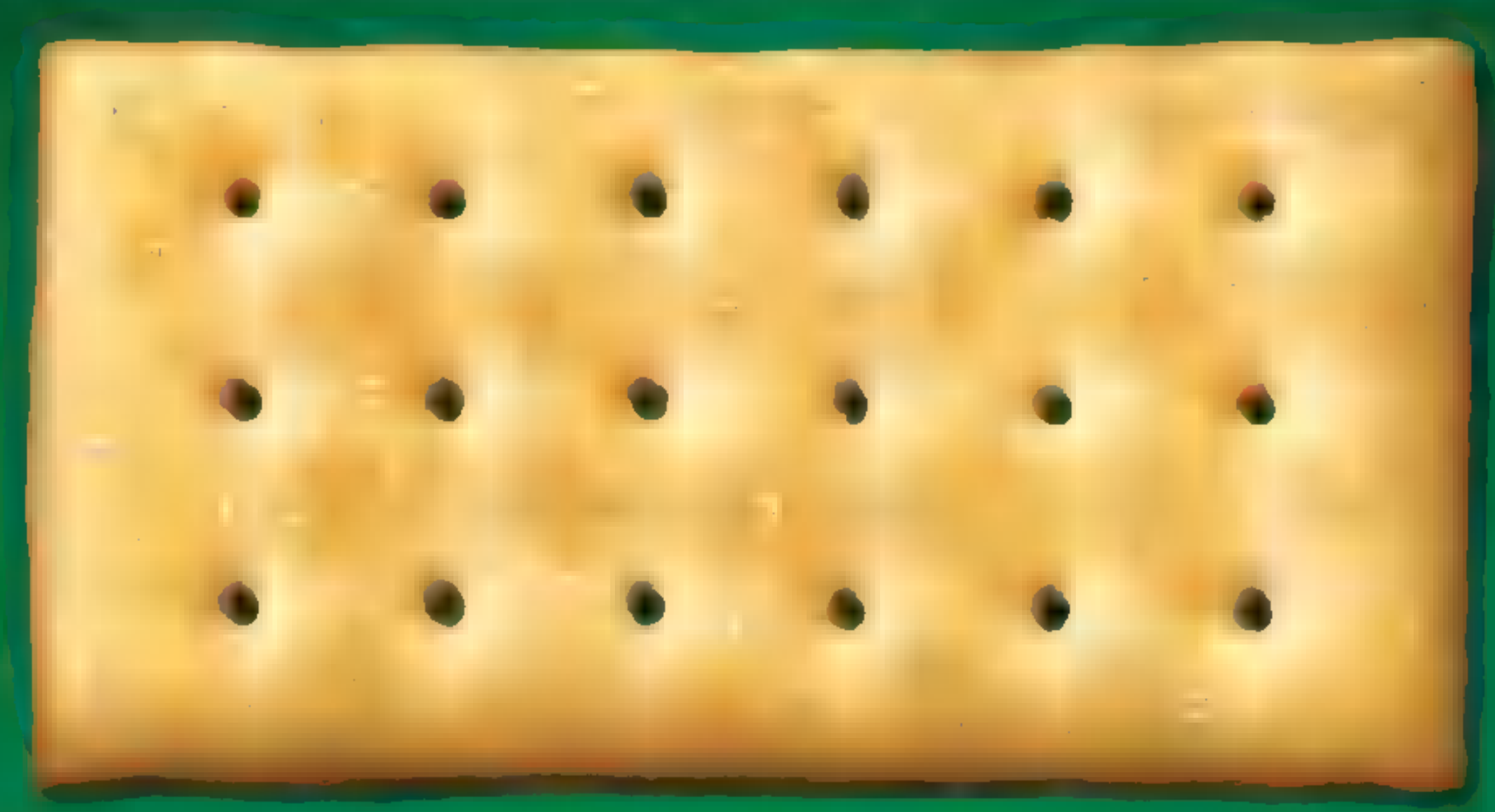
James Snyder West Palm Beach, Florida

One evening Snyder noticed something bizarre in his backyard: A frog hugging a mango tree had swallowed a Christmas light. The 29-year-old snapped this shot, then worked to free the frog.

Navid Baraty San Francisco, California

A 28-year-old Web developer, Baraty likes shooting in the rain "because of the wonderful lighting from all the reflective surfaces." He took this gift of ■ picture just days before Christmas, as shoppers trundled through Union Square.

READERS' CHOICE



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ORIGINAL

The springtime Nowruz holiday is a busy time for families in Kokand, a thriving city in Uzbekistan's Fergana Valley.

More of photojournalist Carolyn Drake's work can be found at carolyndrake.com.

Inside Uzbekistan A country governed by fear is a challenge for a foreigner with cameras and questions. I'd heard stories about this former Soviet republic from ethnic Crimean Tatars who'd left, yet I had few expectations when I arrived. I certainly didn't think it would be so hard to connect with people. Uzbeks don't speak freely, especially to outsiders, and with good reason: The current regime has a record of intimidating and torturing those who have strayed beyond its control. The irony is that, with so few jobs, survival for many depends on deeply unofficial activities such as smuggling, doing business in black markets, and growing unapproved crops.

The heart of Uzbekistan's sanctioned economy is cotton. People are forced to work their lands and sell their yield at low cost to the government, which exports it at great profit—an unfair system made possible by a network of poorly designed, environmentally dangerous canals that effectively carve the country into fiefs.

Given this climate, it was natural that a photographer would make people nervous. Still, some Uzbeks were willing to share with me the rituals of their daily lives, and I tried to use those chances to make tangible images of abstractions like silence and suspicion. I think the picture of the café (above) comes closest to achieving this. It's an everyday scene, yet the reflected shadow above the man's head suggests surveillance, points to an identity hidden just beneath the surface. That was the Uzbekistan I experienced.

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Forty days before this picture was taken, these traditional Uzbek clothes—here adorning the walls in a Khanabad home and worn by the newlywed in the mirror—were wedding presents. The custom is to keep such gifts on display long after the ceremony, so that guests dropping by may admire them.

In Karakalpakstan, an autonomous region of Uzbekistan, schoolgirls share a backstage laugh while rehearsing a performance for Nowruz, the spring holiday signaling the start of a new year.

DAVID DOUBILET

Underwater photographer. Explorer. Artist.
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The Namaz-e-Tawbah, a Muslim daily prayer of repentance, is recited by many in a country where Islam is the dominant faith. Nearly 90 percent of the population is Sunni, though not everyone is devout. Religion was not practiced openly until 1991, when Uzbekistan gained independence from the Soviet Union.

A woman rounds a corner in Andijon, where high walls hem streets and authorities strive to regulate religious practices and inhibit social unrest. In 2005 the city was the site of a massacre in which hundreds of unarmed protesters were shot and killed by government security forces.

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VISIONS OF EARTH

Romania Two young women stroll through Budeşti, chic heels and jackets augmenting traditional church attire. Such styles reflect a migratory trend: After working abroad, many here are carrying back money and modernity.

PHOTO: TIM DIRVEN, PANOS PICTURES

United States Like brushes saturated with paint, the wing scales of a sunset moth drip with color. Shot in a Washington State photo studio using a microscope, their iridescence is revealed only in this close-up view.

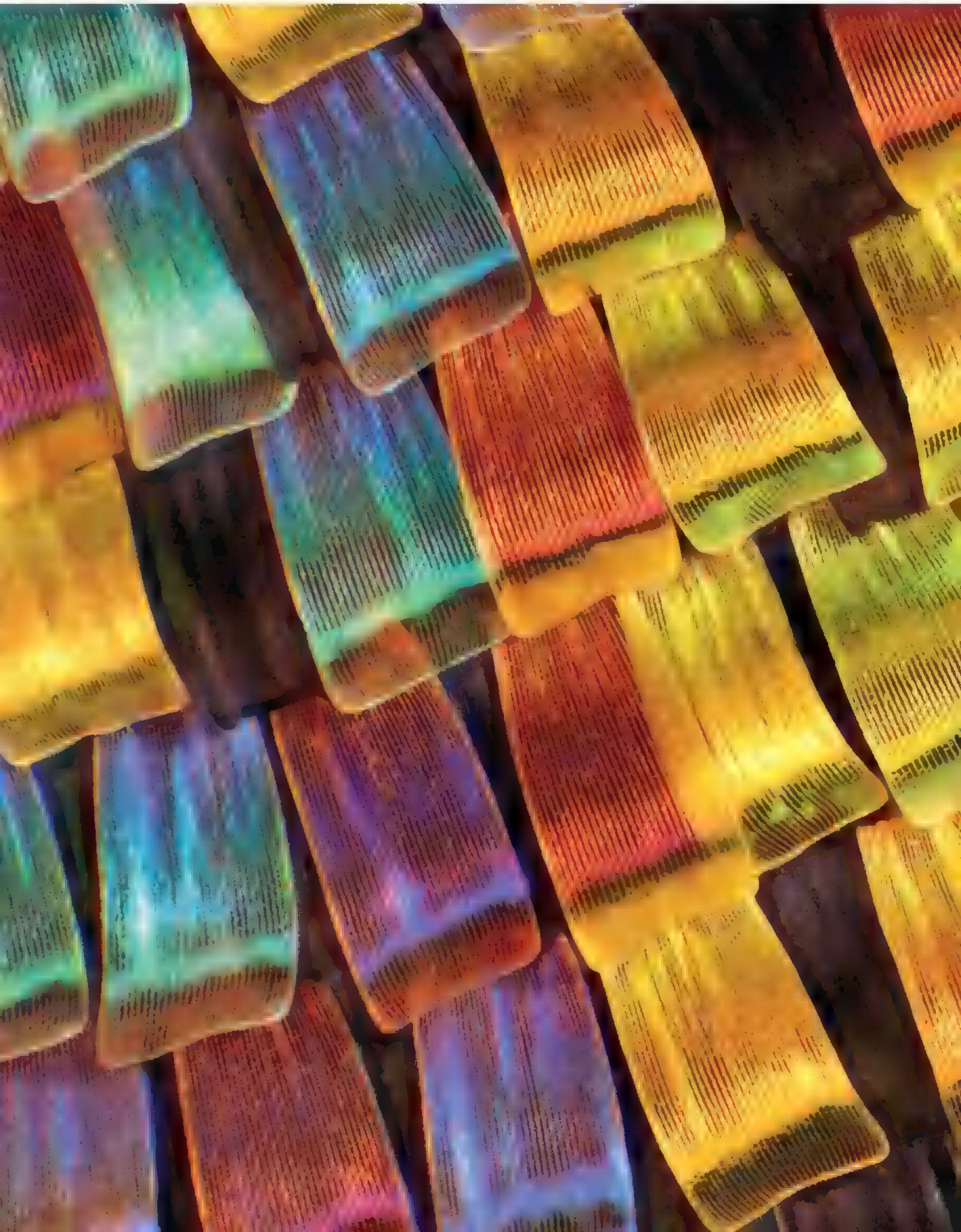
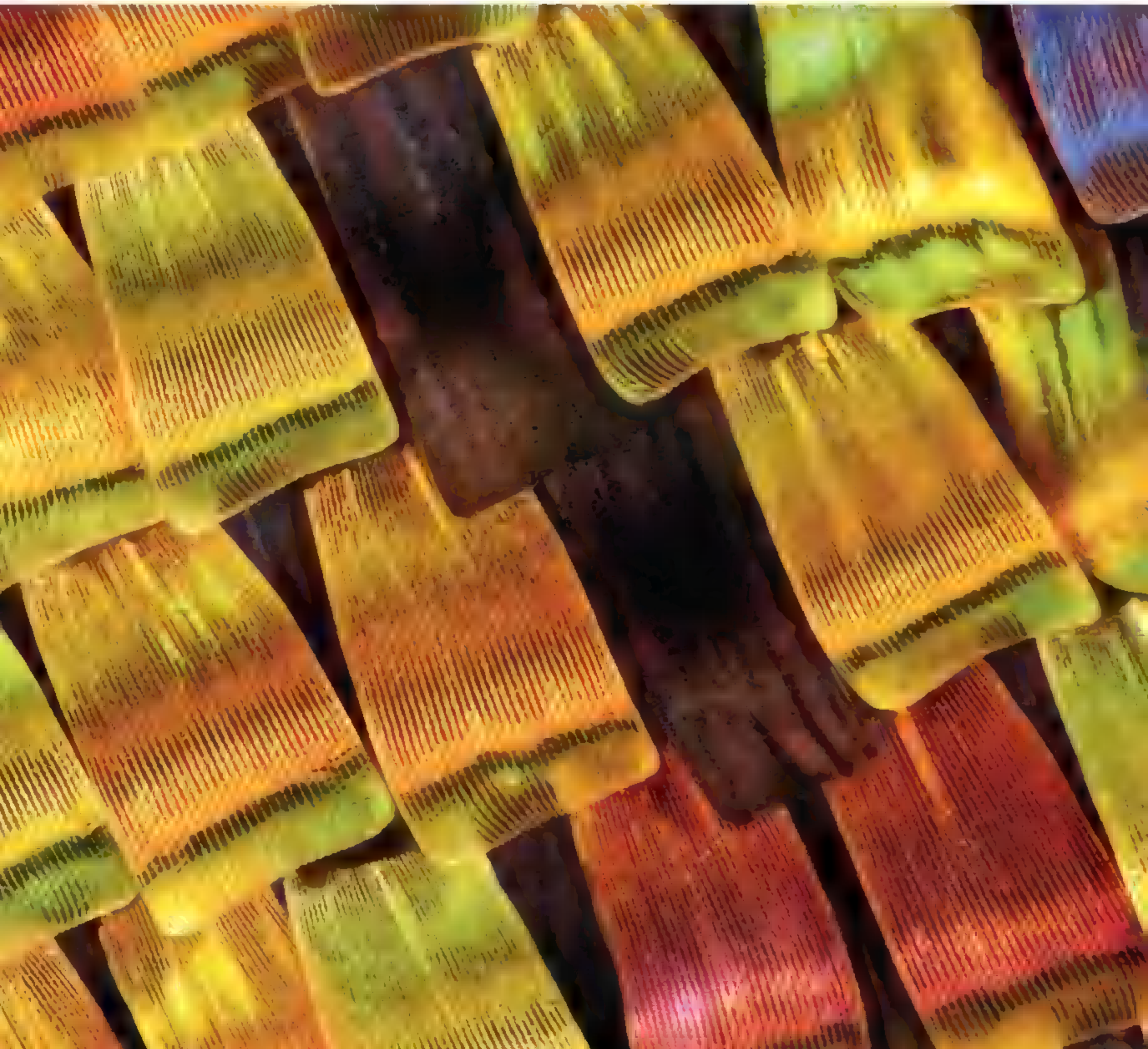
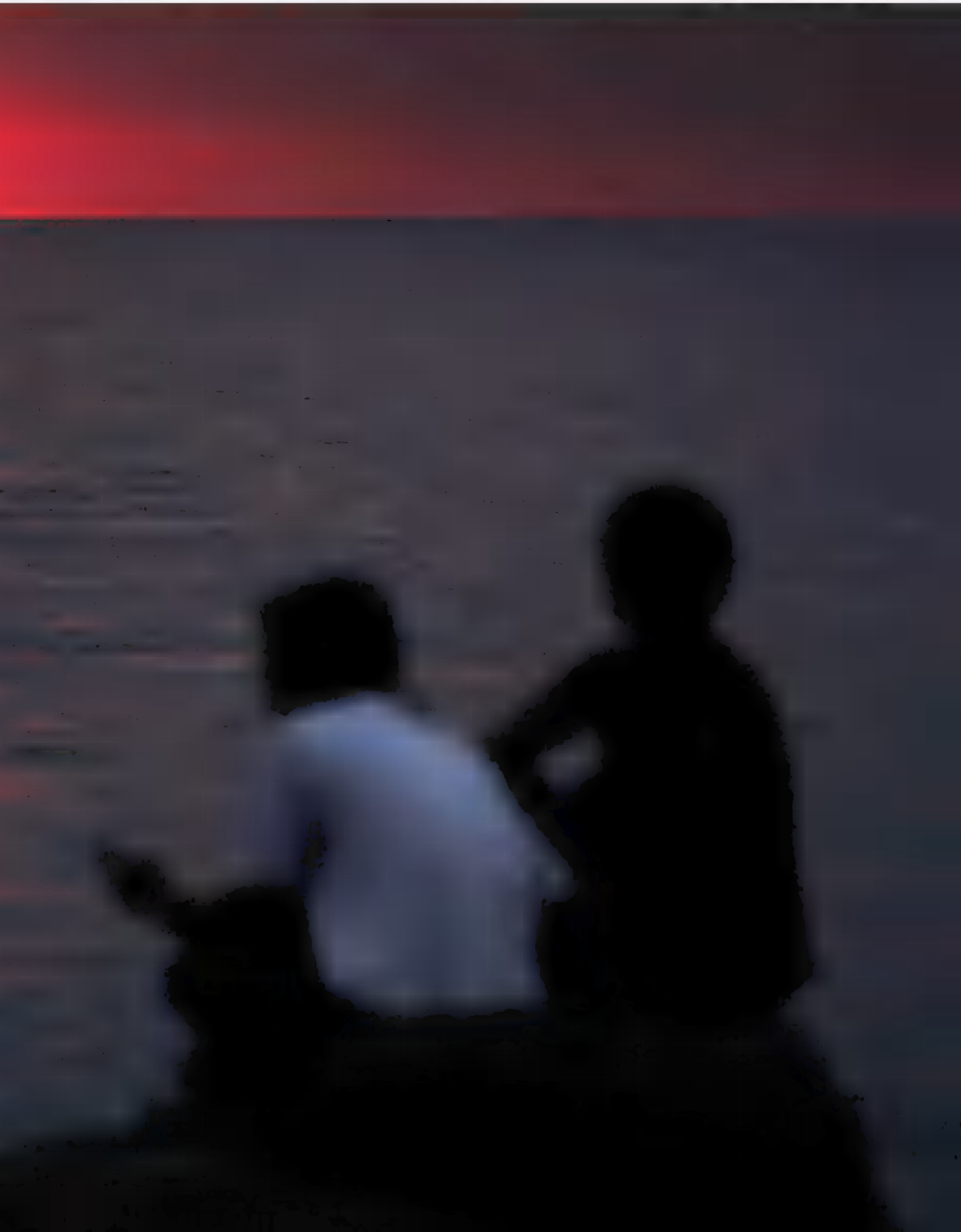


PHOTO: CHARLES KREBS



Philippines Children gaze at the storybook sight of a partial solar eclipse over Manila Bay. The result of a syzygy—an instance when the Earth, moon, and sun are aligned—it was visible on parts of four continents.

PHOTO: GIL NARTEA, AFP/GETTY



IMAGINE THIS BLISTERING RASH ALONG WITH STABBING PAIN

AND YOU'LL HAVE AN IDEA OF WHAT IT CAN BE LIKE TO HAVE SHINGLES.

MERCK

For more information on the availability of ZOSTAVAX through the Merck Vaccine Patient Assistance Program, visit www.merck.com/merckhelps or call 1-877-9 SHINGLES.

IF YOU HAD CHICKENPOX AS A CHILD, YOU COULD GET SHINGLES NOW.

The chickenpox virus is still in your body.

It can resurface as Shingles, a painful, blistering rash. The Shingles rash usually lasts up to 30 days, and for most the pain lessens as the rash heals. But some people who develop Shingles experience long-term pain that can last for months, even years.

ZOSTAVAX is a vaccine that can help prevent Shingles.

ZOSTAVAX is used to prevent Shingles in adults 60 years of age or older. Once you reach age 60, the sooner you get vaccinated, the better your chances of protecting yourself from Shingles. ZOSTAVAX is given as a single shot. ZOSTAVAX cannot be used to treat Shingles, or the nerve pain that may follow Shingles, once you have it. Talk to your health care professional to see if ZOSTAVAX is right for you.

Important Safety Information

ZOSTAVAX may not fully protect everyone who gets the vaccine. You should not get ZOSTAVAX if you are allergic to any of its ingredients, including gelatin and neomycin, have a weakened immune system, take high doses of steroids, or are pregnant or plan to become pregnant. Possible side effects include redness, pain, itching, swelling, warmth, or bruising at the injection site, as well as headache. You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088. Before getting vaccinated, talk to your health care professional about situations you may need to avoid after getting ZOSTAVAX. Please see the Patient Product Information on the adjacent page.

Before you get Shingles, ask about ZOSTAVAX.

ZOSTAVAX®

Zoster Vaccine Live

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Patient Information about ZOSTAVAX® (pronounced "ZOS tah vax") Generic name: Zoster Vaccine Live

You should read this summary of information about ZOSTAVAX[1] before you are vaccinated. If you have any questions about ZOSTAVAX after reading this leaflet, you should ask your health care provider. This information does not take the place of talking about ZOSTAVAX with your doctor, nurse, or other health care provider. Only your health care provider can decide if ZOSTAVAX is right for you.

What is ZOSTAVAX and how does it work?

ZOSTAVAX is a vaccine that is used for adults 60 years of age or older to prevent shingles (also known as zoster).

ZOSTAVAX contains a weakened chickenpox virus (varicella-zoster virus).

ZOSTAVAX works by helping your immune system protect you from getting shingles. If you do get shingles even though you have been vaccinated, ZOSTAVAX may help prevent the nerve pain that can follow shingles in some people.

ZOSTAVAX may not protect everyone who gets the vaccine. ZOSTAVAX cannot be used to treat shingles once you have it.

What do I need to know about shingles and the virus that causes it?

Shingles is caused by the same virus that causes chickenpox. Once you have had chickenpox, the virus can stay in your nervous system for many years. For reasons that are not fully understood, the virus may become active again and give you shingles. Age and problems with the immune system may increase your chances of getting shingles.

Shingles is a rash that is usually on one side of the body. The rash begins as a cluster of small red spots that often blister. The rash can be painful. Shingles rashes usually last up to 30 days and, for most people, the pain associated with the rash lessens as it heals.

Who should not get ZOSTAVAX?

You should not get ZOSTAVAX if you:

- are allergic to any of its ingredients.
- are allergic to gelatin or neomycin.
- have a weakened immune system (for example, an immune deficiency, leukemia, lymphoma, or HIV/AIDS).
- take high doses of steroids by injection or by mouth.
- are pregnant or plan to get pregnant.

You should not get ZOSTAVAX to prevent chickenpox.

Children should not get ZOSTAVAX.

How is ZOSTAVAX given?

ZOSTAVAX is given as a single dose by injection under the skin.

What should I tell my health care provider before I get ZOSTAVAX?

You should tell your health care provider if you:

- have or have had any medical problems.
- take any medicines, including nonprescription medicines, and dietary supplements.
- have any allergies, including allergies to neomycin or gelatin.
- had an allergic reaction to another vaccine.
- are pregnant or plan to become pregnant.
- are breast-feeding.

Tell your health care provider if you expect to be in close contact (including household contact) with newborn infants, someone who may be pregnant and has not had chickenpox or been vaccinated against chickenpox, or someone who has problems with their immune system. Your health care provider can tell you what situations you may need to avoid.

What are the possible side effects of ZOSTAVAX?

The most common side effects that people in the clinical studies reported after receiving the vaccine include:

- redness, pain, itching, swelling, warmth, or bruising where the shot was given.
- headache.

The following additional side effects have been reported in general use with ZOSTAVAX:

- allergic reactions, which may be serious and may include difficulty in breathing or swallowing. If you have an allergic reaction, call your doctor right away.
- fever
- hives at the injection site
- joint pain
- muscle pain
- rash
- rash at the injection site
- swollen glands near the injection site (that may last a few days to a few weeks)

Tell your health care provider if you have any new or unusual symptoms after you receive ZOSTAVAX.

What are the ingredients of ZOSTAVAX?

Active Ingredient: a weakened form of the varicella-zoster virus.

Inactive Ingredients: sucrose, hydrolyzed porcine gelatin, sodium chloride, monosodium L-glutamate, sodium phosphate dibasic, potassium phosphate monobasic, potassium chloride.

What else should I know about ZOSTAVAX?

Vaccinees and their health care providers are encouraged to call (800) 986-8999 to report any exposure to ZOSTAVAX during pregnancy.

This leaflet summarizes important information about ZOSTAVAX.

If you would like more information, talk to your health care provider or visit the website at www.ZOSTAVAX.com or call 1-800-622-4477.

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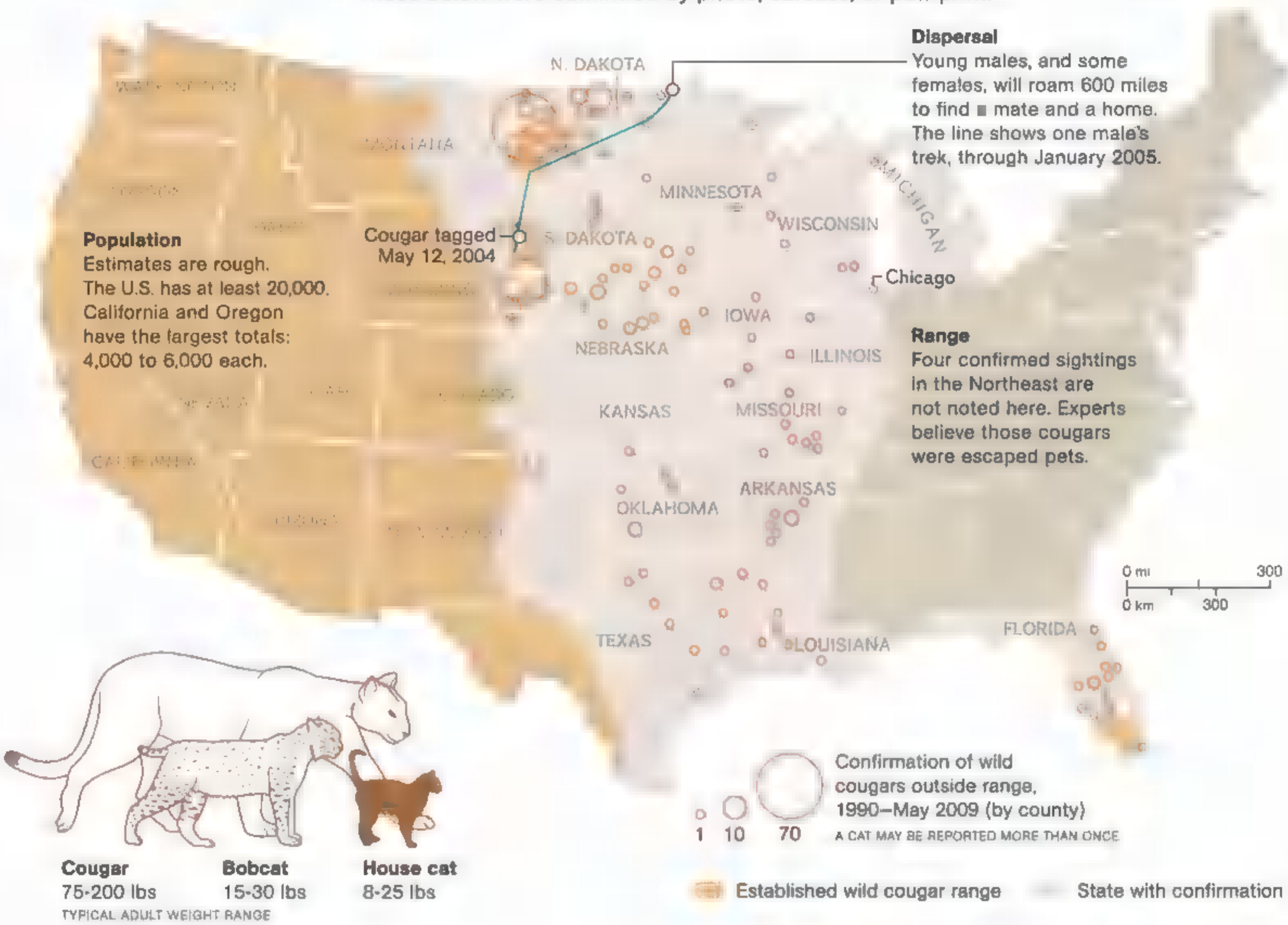
Where the Cougars Are

Hundreds of sightings are reported to the Cougar Network each year.
Those below were confirmed by photo, carcass, or paw print.



Call them cougars, mountain lions, or pumas. Americans think they see them everywhere. That's no surprise in the West; strict management helped the predatory cat make a remarkable recovery after "varmint hunters" took numbers very low by the mid-1900s. Eastbound cougars are also turning up in the Midwest. South Dakota has a breeding population of 200-plus; just last year, Chicago cops cornered and shot one on the North Side.

But Eastern sightings are suspect. Florida has 70 to 100 wild cougars, a remnant from the days when the cat covered the continent. Other folks likely glimpsed a bobcat or a darned big house cat. "Imaginations get carried away," says Clay Nielsen, wildlife ecologist at Southern Illinois University Carbondale. If you do meet a cougar —and really, the cat tries to avoid humans—experts say, Don't run! Otherwise, a 150-pound cat might mistake you for a deer dinner. *—Marc Silver*

Cougars are settling in—and climbing up—in Nebraska.

NGM MAPS SOURCES: COUGAR NETWORK; SOUTH DAKOTA STATE UNIVERSITY. NG ART
PHOTO: DEAN STUDNICKA, NEBRASKA GAME AND PARKS COMMISSION

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Lithium Rush

Just as gas-powered autos depend on oil, the world's future fleet of electric cars may well depend on an obscure element now mined in only a handful of places: lithium. Because it is the world's lightest metal and good at holding a charge, lithium in batteries can deliver the energy electric cars need without weighing them down or requiring frequent recharging stops. Present in trace amounts throughout Earth's oceans and crust, lithium is amazingly versatile. It can run laptop computers, treat bipolar disorder (in powdered form, though scientists don't know exactly how it prevents mood swings), and even give ceramics a brighter glaze.

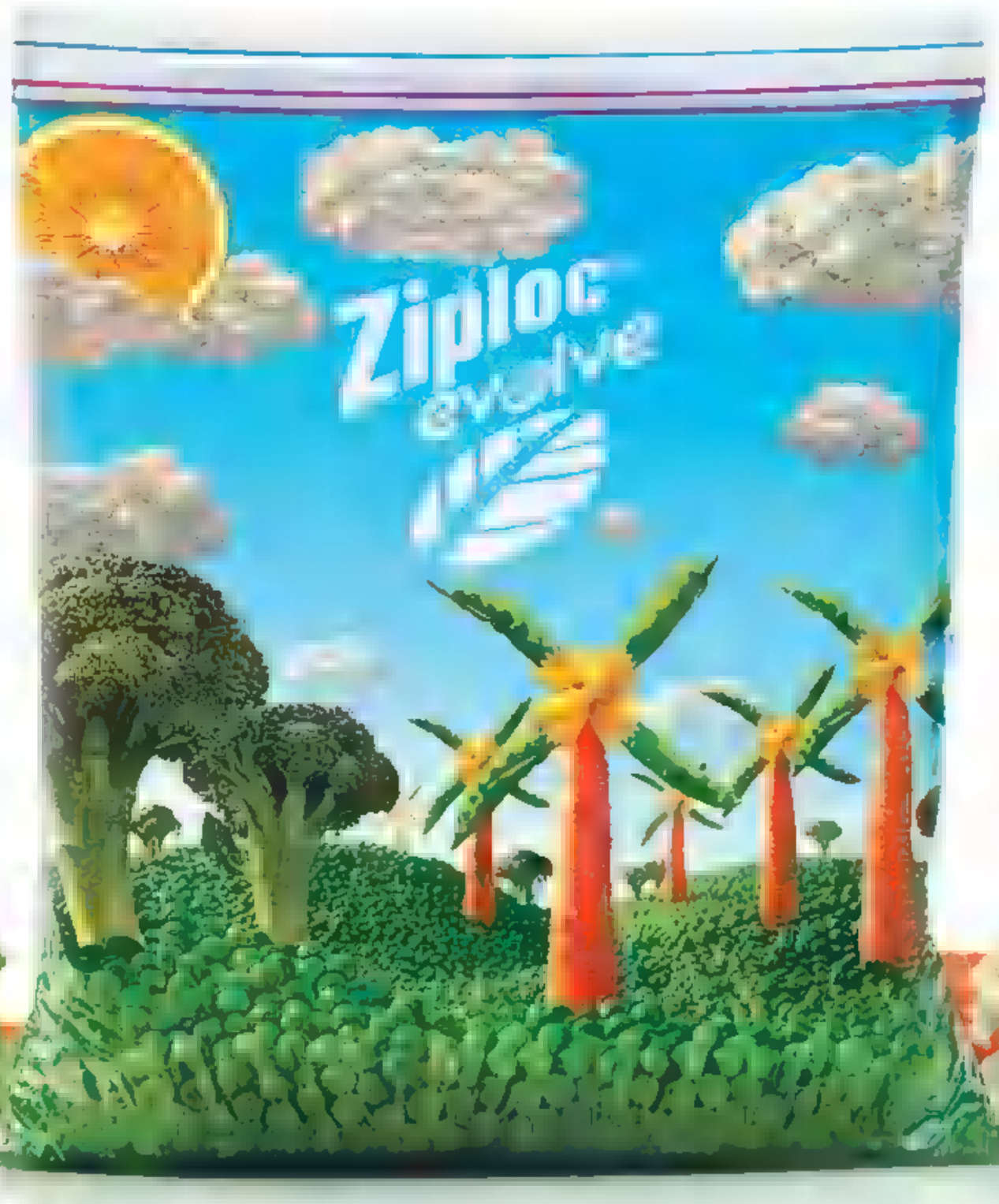
Lithium is mined as an ore in rocks and as a mineral suspended in briny solutions found beneath salt flats. In recent years Chile has developed its lithium-rich salt flats to become the world's top producer. With rising demand, new deposits will have to be tapped—including an estimated 5.95 million tons beneath a high-altitude desert in Bolivia. *—Karen E. Lange*

HOW IT WORKS

In a lithium-ion battery, lithium is the positive electrode, graphite the negative. Ions flit across the plastic, producing energy. Layers of copper hold it all together.

LITHIUM MINE PRODUCTION, 2008
(in tons)

PHOTO: MARK THIESSEN, NG PHOTOGRAPHER
CHART SOURCE: USGS



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Made with 25% less plastic* and made with wind energy.†

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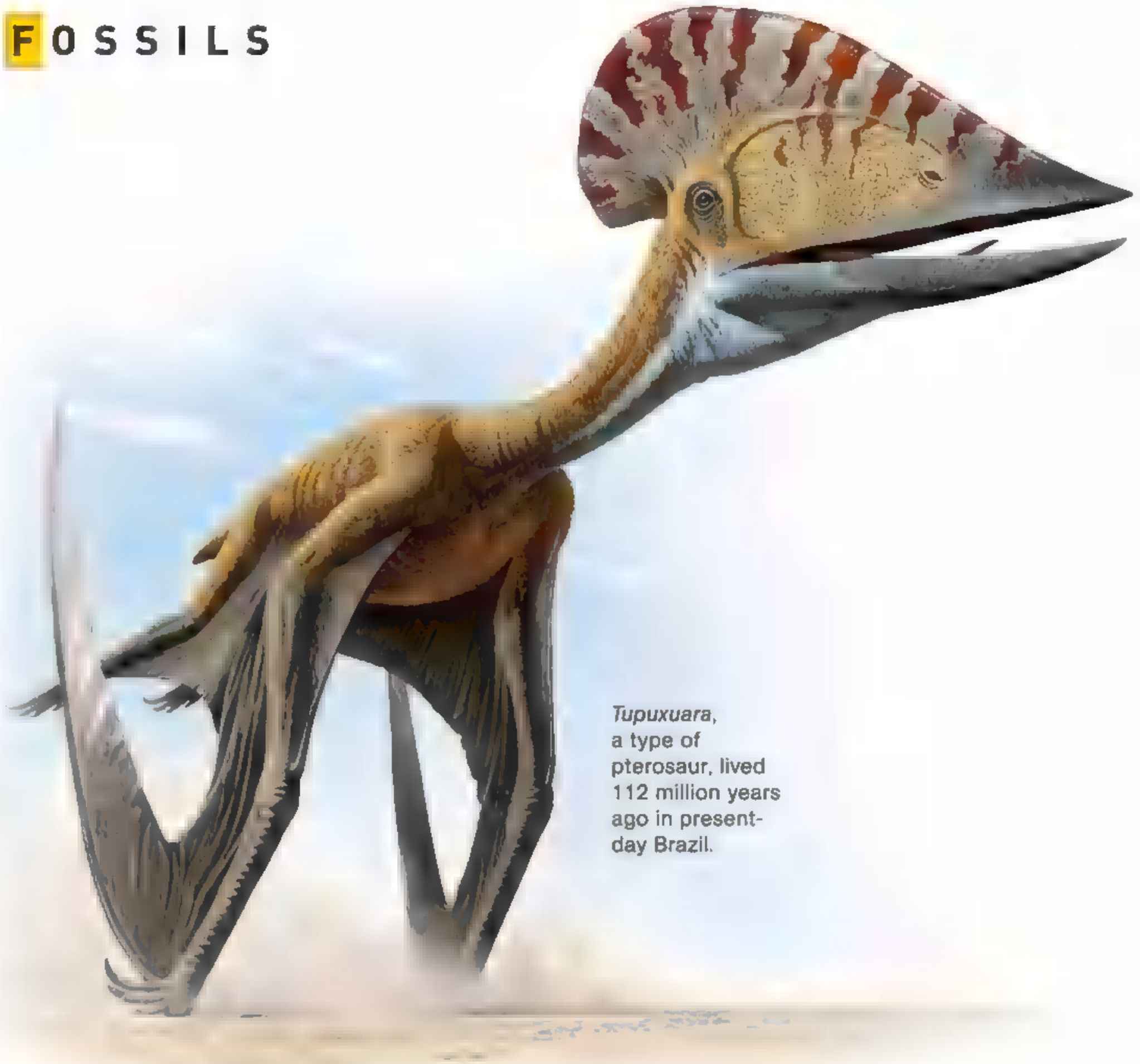
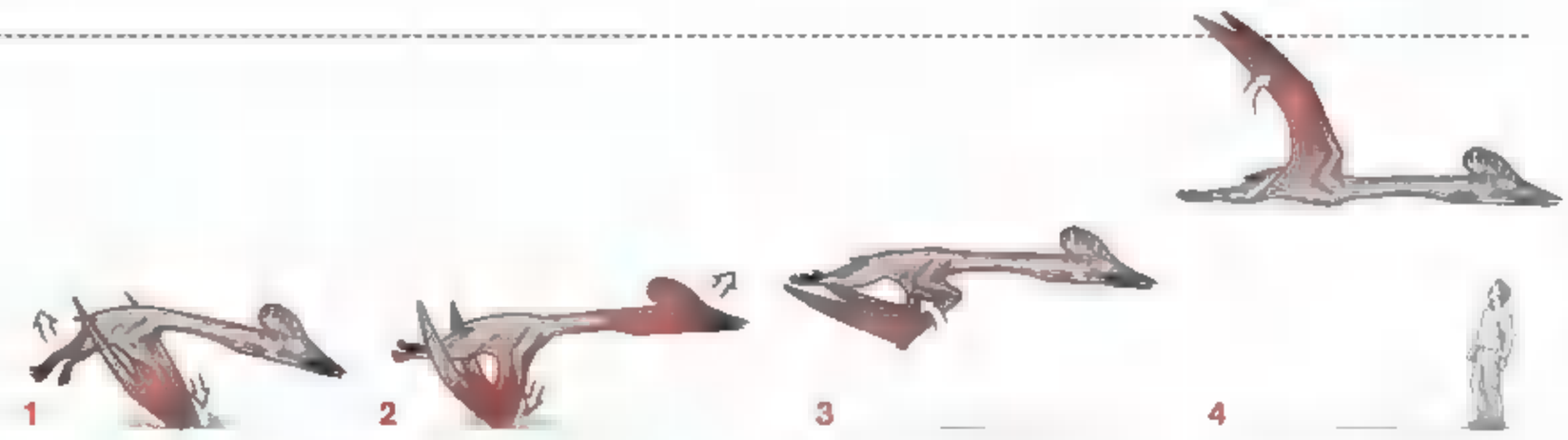


Tupuxuara, a type of pterosaur, lived 112 million years ago in present-day Brazil.

Pterosaur Takeoff They were weirdly shaped weaklings, giraffe-tall hang gliders forced to hurl themselves off cliffs to get airborne. At least that's the traditional view of the flying reptiles called pterosaurs, which went extinct along with dinosaurs some 65 million years ago. But ■ novel idea of pterosaur flight has caught the notice of paleontologists worldwide. According to Johns Hopkins doctoral student Michael Habib, these dragon-like creatures—the largest of which may have weighed well over 500 pounds—had the power to take off from flat ground. Habib, who used to study bird flight, says pterosaurs' wing bones were too massive for them to have simply been frail gliders. But beefy wings make sense if they flew by first tipping forward off comparatively spindly back legs, then using their front limbs to explosively leapfrog into the air. If that theory takes wing, pterosaurs could gain a muscular new profile in Mesozoic history. *—Chris Carroll*

WINGING IT
A pterosaur leaned forward on its wings and, with ■ catapult-like action, hurtled off the ground. Once aloft, it flapped away, according to a new theory.



ART: RAÚL MARTÍN (TOP); HIRAM HENRIQUEZ, NG STAFF (BOTTOM)

BRIDGESTONE

the GROUND *moves*

UNDER YOU SO EFFORTLESSLY

THAT YOU HAVE TO WONDER:

IS THE PLANET JUST REVOLVING

ON ITS AXIS OR ARE YOUR TIRES

MAKING IT SPIN THAT WAY?

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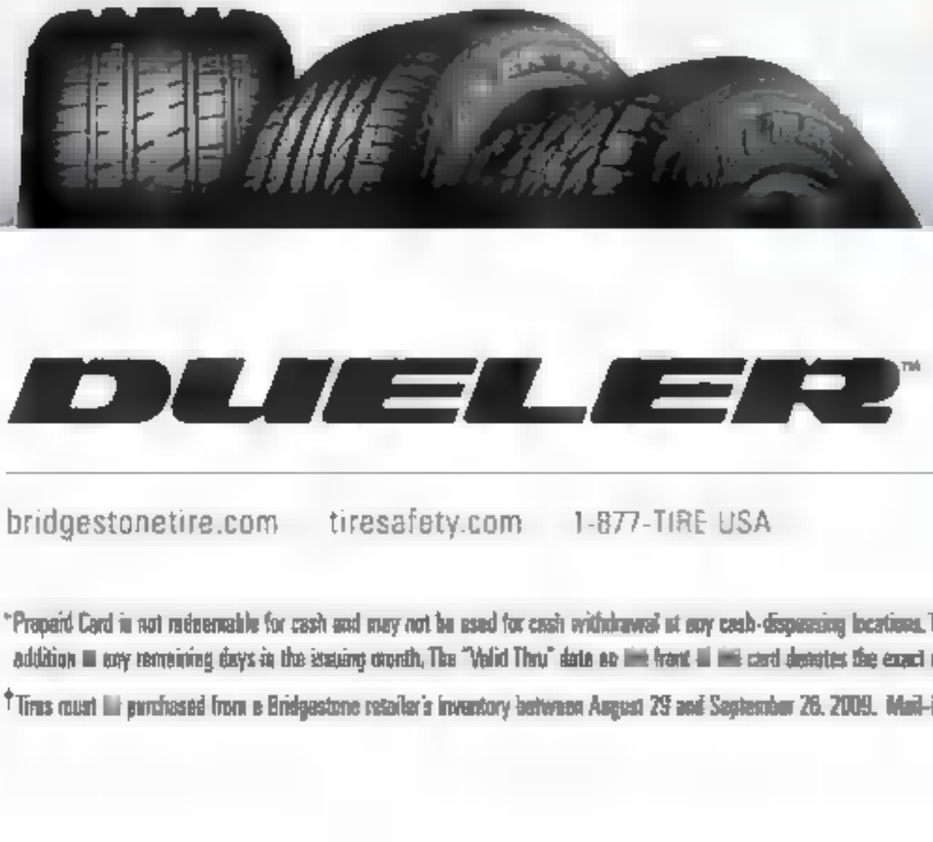

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†Tires must be purchased from a Bridgestone retailer's inventory between August 29 and September 26, 2009. Mail-in claim form required. Restrictions and limitations apply. See your participating Bridgestone retailer for complete details.

A 1959 Volvo in Sweden was the first car to feature a three-point seat belt.

Saved By the Belt Few inventors can claim credit for saving more than a million lives, but Nils Bohlin is one of them. Fifty years ago the Volvo engineer modified an airplane device and came up with the three-point seat belt—one strap across the hips, one across the chest, both anchored to the same point on the car floor.

It was ■ milestone advance in auto safety, especially in the car-crazy U.S., where it was rolled out in 1963. Yet manufacturers of the time worried that it would remind consumers that cars could be unsafe. Misled motorists saw it as a danger, a nuisance, or both. That attitude persisted for decades: In 1981 only 11 percent of American drivers were buckling up.

Now, however, thanks to state seat belt laws, the national "Click It or Ticket" campaign, and automated in-car reminders, U.S. usage is at 80 percent. Engineers, meanwhile, are developing and refining sci-fi safety technologies like collision-avoidance and drowsiness-monitoring systems. Experts say these ideas have promise, but Bohlin's simple seat belt is a proven lifesaver. *—Winona Dimeo-Ediger*

MILESTONES IN U.S. CAR SAFETY

1899 Henry H. Bliss is the first pedestrian killed in a traffic accident when he is hit by a New York City taxi.

1901 Oldsmobile debuts the speedometer; Connecticut puts limits on auto speed (12 mph in cities, 15 mph outside them).

1920 Detroit installs a three-color stoplight.

1937 Chrysler unveils ■ safer dashboard and padded seat backs.

1949 A Nash model features lap belts.

1952 A "safety cushion," the precursor to the modern air bag, is first conceived.

1963 Some Volvos include three-point belts in their front seats.

1966 Crash-test dummies are modified for car-safety tests (in time replacing cadavers, chimps, and hogs).

1968 Federal law requires all passenger cars to carry seat belts.

1974 An "inconvenienced" public persuades Congress to repeal a law ensuring cars can't start until seat belts are buckled.

1984 New York is the first state to require the use of seat belts.

1995 All states but New Hampshire have broad seat belt laws.

1998 All autos must have dual front air bags.

2008 Automakers trot out alarm systems that rouse sleepy drivers.

2020 Volvo envisions an "injury-proof" car.

PHOTOS: IRA BLOCK (TOP); REBECCA HALE, NG STAFF

Coachella Valley Fringe-toed Lizard *(Uma inornata)*
Size: Head and body length, 7 - 12.4 cm (2.8 - 4.9 inches); tail, approx. the same
Weight: Approx. 20 g (0.7 oz) **Habitat:** Coachella Valley area of California, from sea level to elevations of about 1,600 feet **Surviving number:** Unknown; populations declining

Photographed by Jenny E. Ross

WILDLIFE AS CANON SEES IT

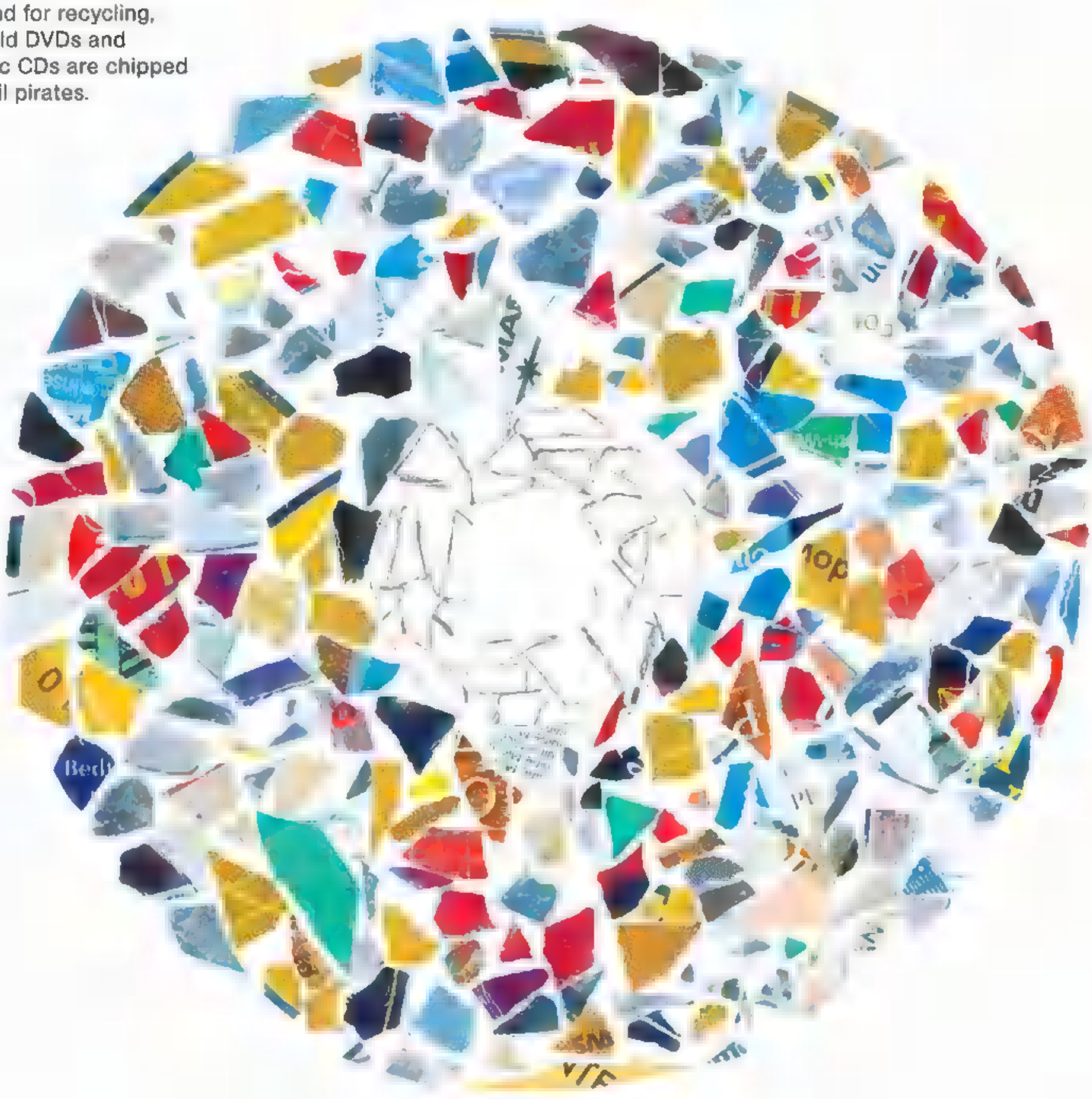
Sandy is just dandy. The Coachella Valley fringe-toed lizard is perfectly at ease with the fine, blowing sand and scorching heat of its California home. Its namesake fringed toes allow it to run quickly over sand without sinking, while its jaw, eyelids, ears and nostrils are all adapted to keep sand out. Active during the day, the dune dweller simply burrows into the sand for relief when the mercury rises to extremes. This is also an effective strategy for avoiding predators. But the sand-wise lizard can't hide from habitat loss, which has been driven by development and the influx of exotic vegetation. Its precious sand is slipping away.

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit **canon.com/environment** to learn more.

Canon

ENVIRONMENT

Bound for recycling, unsold DVDs and music CDs are chipped to foil pirates.



Disc Demolition Count your damaged and unwanted CDs and DVDs. Multiply by millions of folks like you. Add in the business world's used data CDs and music, video game, and movie returns. The total is billions of trashed discs a year. How do you keep them out of the landfill?

Some recycling firms buy big batches of discs from businesses. The prize is the polycarbonate plastic covering the reflective data layer. Typically, a chemical bath removes ink, lacquer, and aluminum. The plastic is then melted and molded into eyeglass frames, car parts, and fences. Alas, says Darby Hoover of the Natural Resources Defense Council, the eco-impact of these steps is "hard to track"—especially at facilities in China.

Big-time recyclers aren't as interested in an individual's wee array of bum discs. San Francisco is one of the few American cities that picks up CDs curbside for recycling. If you don't mind paying postage, you can mail your discs to GreenDisk or the CD Recycling Center of America. If you do mind, be patient: Drop-off boxes are arriving at some chain stores.

Another option is to revive damaged discs. The Disc-Go-Devil device gets rid of scratches by buffing the plastic surface. Video-rental firms use the technology; stores may soon offer it. So, marred CDs and DVDs can live on until the day when all media is downloaded. By then there should be safe, convenient ways to recycle discs. *—Marc Silver*

PHOTO: MARK THIESSEN, NG PHOTOGRAPHER

There are 2 sources of cholesterol.

Food & Family.

Only VYTORIN treats both.

It's important to eat healthy and stay active, but when that's not enough, talk to your doctor about treating the 2 sources of cholesterol with VYTORIN. VYTORIN contains two cholesterol medicines, *Zetia* (ezetimibe) and *Zocor* (simvastatin), in a single tablet.

VYTORIN is the only product that helps block cholesterol that comes from food and reduces the cholesterol your body makes naturally, based on family history. And VYTORIN can dramatically lower your bad cholesterol 45%–60%. (Average effect depending on dose; 52% at the usual starting dose.)

VYTORIN contains two cholesterol medicines, *Zetia* (ezetimibe) and *Zocor* (simvastatin), in a single tablet. **VYTORIN has not been shown to reduce heart attacks or strokes more than *Zocor* alone.**

Ask your doctor if VYTORIN is right for you. Or, to learn more, call **1-877-VYTORIN** or visit **vytorin.com.**

To find out if you qualify, call 1-800-347-7503

Merck/Schering-Plough Patient Assistance Program

Important Risk Information About VYTORIN: VYTORIN is a prescription tablet and isn't right for everyone, including women who are nursing or pregnant or who may become pregnant, and anyone with liver problems.

Unexplained muscle pain or weakness could be a sign of a rare but serious side effect and should be reported to your doctor right away. VYTORIN may interact with other medicines or certain foods, increasing your risk of getting this serious side effect. So tell your doctor about any other medications you are taking.

Your doctor may do simple blood tests before and during treatment with VYTORIN to check for liver problems. Side effects included headache, muscle pain, and diarrhea. You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

Please read the more detailed information about VYTORIN on the adjacent page.

MERCK / Schering-Plough Pharmaceuticals

VYTORIN®

(ezetimibe/simvastatin)

Treat the 2 sources of cholesterol.

VYTORIN® (EZETIMIBE/SIMVASTATIN) TABLETS
PATIENT INFORMATION ABOUT *VYTORIN* (VI-tor-in)

Generic name: ezetimibe/simvastatin tablets

Read this information carefully before you start taking VYTORIN. Review this information each time you refill your prescription for VYTORIN as there may be new information. This information does not take the place of talking with your doctor about your medical condition or your treatment. If you have any questions about VYTORIN, ask your doctor. Only your doctor can determine if VYTORIN is right for you.

WHAT IS *VYTORIN*?

VYTORIN is a medicine used to lower levels of total cholesterol, LDL (bad) cholesterol, and fatty substances called triglycerides in the blood. In addition, VYTORIN raises levels of HDL (good) cholesterol. VYTORIN is for patients who cannot control their cholesterol levels by diet and exercise alone. You should stay on a cholesterol-lowering diet while taking this medicine.

VYTORIN works to reduce your cholesterol in two ways. It reduces the cholesterol absorbed in your digestive tract, as well as the cholesterol your body makes by itself. VYTORIN does not help you lose weight. VYTORIN has not been shown to reduce heart attacks or strokes more than simvastatin alone.

WHO SHOULD NOT TAKE *VYTORIN*?

Do not take VYTORIN:

- If you are allergic to ezetimibe or simvastatin, the active ingredients in VYTORIN, or to the inactive ingredients. For a list of inactive ingredients, see the "Inactive ingredients" section at the end of this information sheet.
- If you have active liver disease or repeated blood tests indicating possible liver problems.
- If you are pregnant, or think you may be pregnant, or planning to become pregnant or breast-feeding.
- If you are ■ woman of childbearing age, you should use an effective method of birth control to prevent pregnancy while using VYTORIN.

VYTORIN has not been studied in children under 10 years of age.

WHAT SHOULD I TELL MY DOCTOR BEFORE AND WHILE TAKING *VYTORIN*?

Tell your doctor right away if you experience unexplained muscle pain, tenderness, or weakness. This is because on rare occasions, muscle problems can be serious, including muscle breakdown resulting in kidney damage.

The risk of muscle breakdown is greater at higher doses of VYTORIN.

The risk of muscle breakdown is greater in patients with kidney problems.

Taking VYTORIN with certain substances can increase the risk of muscle problems. It is particularly important to tell your doctor if you are taking any of the following:

- cyclosporine
- danazol
- antifungal agents (such as itraconazole or ketoconazole)
- fibric acid derivatives (such as gemfibrozil, bezafibrate, or fenofibrate)
- the antibiotics erythromycin, clarithromycin, and telithromycin
- HIV protease inhibitors (such as indinavir, nelfinavir, ritonavir, and saquinavir)
- the antidepressant nefazodone
- amiodarone (a drug used to treat an irregular heartbeat)
- verapamil (a drug used to treat high blood pressure, chest pain associated with heart disease, or other heart conditions)
- large doses (≥1 g/day) of niacin or nicotinic acid
- large quantities of grapefruit juice (>1 quart daily)

It is also important to tell your doctor if you are taking coumarin anticoagulants (drugs that prevent blood clots, such as warfarin).

Tell your doctor about any prescription and nonprescription medicines you are taking or plan to take, including natural or herbal remedies.

Tell your doctor about all your medical conditions including allergies.

Tell your doctor if you:

- drink substantial quantities of alcohol or ever had liver problems. VYTORIN® (ezetimibe/simvastatin) may not be right for you.
- are pregnant or plan to become pregnant. Do not use VYTORIN if you are pregnant, trying to become pregnant or suspect that you are pregnant. If you become pregnant while taking VYTORIN, stop taking it and contact your doctor immediately.
- are breast-feeding. Do not use VYTORIN if you are breast-feeding.

Tell other doctors prescribing a new medication that you are taking VYTORIN.

HOW SHOULD I TAKE *VYTORIN*?

- Take VYTORIN once a day, in the evening, with or without food.
- Try to take VYTORIN as prescribed. If you miss a dose, do not take an extra dose. Just resume your usual schedule.
- Continue to follow a cholesterol-lowering diet while taking VYTORIN. Ask your doctor if you need diet information.
- Keep taking VYTORIN unless your doctor tells you to stop. If you stop taking VYTORIN, your cholesterol may rise again.

WHAT SHOULD I DO IN CASE OF AN OVERDOSE?

Contact your doctor immediately.

WHAT ARE THE POSSIBLE SIDE EFFECTS OF *VYTORIN*?

See your doctor regularly to check your cholesterol level and to check for side effects. Your doctor may do blood tests to check your liver before you start taking VYTORIN and during treatment.

In clinical studies patients reported the following common side effects while taking VYTORIN: headache, muscle pain, and diarrhea (see What should I tell my doctor before and while taking VYTORIN?).

The following side effects have been reported in general use with VYTORIN or with ezetimibe or simvastatin tablets (tablets that contain the active ingredients of VYTORIN):

- allergic reactions including swelling of the face, lips, tongue, and/or throat that may cause difficulty in breathing or swallowing (which may require treatment right away), rash, hives; raised red rash, sometimes with target-shaped lesions; joint pain; muscle pain; alterations in some laboratory blood tests; liver problems (sometimes serious); inflammation of the pancreas; nausea; dizziness; tingling sensation; depression; gallstones; inflammation of the gallbladder; trouble sleeping; poor memory.

Tell your doctor if you are having these or any other medical problems while on VYTORIN. This is <u>not</u> ■ complete list of side effects. For a complete list, ask your doctor or pharmacist.

GENERAL INFORMATION ABOUT *VYTORIN*

Medicines are sometimes prescribed for conditions that are not mentioned in patient information leaflets. Do not use VYTORIN for a condition for which it was not prescribed. Do not give VYTORIN to other people, even if they have the same condition you have. It may harm them.

This summarizes the most important information about VYTORIN. If you would like more information, talk with your doctor. You can ask your pharmacist or doctor for information about VYTORIN that is written for health professionals. For additional information, visit the following web site: vytorin.com.

Inactive ingredients:
Butylated hydroxyanisole NF, citric acid monohydrate USP, croscarmellose sodium NF, hypromellose USP, lactose monohydrate NF, magnesium stearate NF, microcrystalline cellulose NF, and propyl gallate NF.

Issued May 2009

VYTORIN®
(ezetimibe/simvastatin) tablets

MERCK / Schering-Plough Pharmaceuticals

Manufactured for:
Merck/Schering-Plough Pharmaceuticals
North Wales, PA 19454, USA

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Perfect imperfection, the natural raw 2 carat diamond

Ready for some rough stuff? We recently found a rare cache of extremely large uncut diamonds at an extraordinary price.

Sometimes it's impossible to improve on perfection. When the world's most desired stone is pulled from the ground, why not just brush off the earth and leave it alone? White cut diamonds may be nice for a polite kiss on the cheek, but extra large uncut diamonds can really ignite some raw passion. And isn't that what a great piece of jewelry is all about? These few rare 2 carat plus natural stones will certainly turn up your thermostat.

A real diamond in the rough

For centuries, large raw diamonds were treasured without a hint of facet or polish. We believe the early artisans were on to something. After a search through countries on four continents, we have found a cache of rare, very large, 2 carat plus uncut diamonds at a spectacular price from our Belgium dealer. Major gemstone experts across the globe have commented that rough diamonds will be the fastest growing trend on "the red carpet" this year and our long love affair with flawless cut white gemstones may have some competition. All one has to do is flip through the world's most exclusive catalog to find that "rough is all the rage." Our luxury retail friends in Texas recently featured a raw solitaire for $6,000, but they buy in such small quantities that they cannot compete with us on price. You see, Stauer is one of the largest gemstone buyers in the world and last year bought over 3 million carats of emeralds. No regular jewelry store can come anywhere close to that volume.

Similar rough diamonds sell elsewhere for thousands! *Please compare the size and price of our raw diamond in the Stauer Raw Diamond Necklace with those at your local jewelry store.*

Equal parts "rough" and "refined"

Our ***Raw Diamond Necklace*** is a balanced blend of geology and geometry. Each one-of-a-kind raw diamond is fitted by hand into its "cage," a crisscross embrace of gold vermeil over the finest .925 sterling silver, bead-set with 18 round diamonds. The caged diamond hangs from a triangular bail with an additional 8 diamonds (26 total). The pendant is suspended from an 18" gold vermeil rope chain with spring ring clasp. Each raw diamond is naturally unique. This is an extremely limited edition since it took us 3 years to find this small cache of stones.

Show off your Stauer ***Raw Diamond Necklace*** for 30 days. If you're not feeling the rush of raw, large diamonds, simply return it for a full refund of your purchase price. But if you feel like experiencing the unique perfection of natural uncut beauty, you have found the way.

Keep in mind that each raw diamond is completely different. The shape, shine and color will vary. But your caged Raw Diamond Necklace will forever remain a reminder of the unspoiled, organic beauty of nature.

Stauer Raw Diamond Necklace *only* $295 +s&h
(2 carat minimum for raw stone)
***Also available*—5 carat raw diamond in solid 14K gold**
Please call for details.
Call now to take advantage of this limited offer.

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Smart Luxuries—Surprising Prices

Facing Beggars In a downturn, begging goes on an upswing. "You do see more of it," says Roughan MacNamara of Focus Ireland, which aids the homeless. A typical government response is to crack down. Ireland, for instance, is rewriting 1847 anti-vagrancy laws so that police officers can round up "aggressive" beggars, deemed a threat to pedestrians, businesses, and tourism.

Anti-begging laws are gaining popularity in North America as well, says University of Toronto criminologist Joe Hermer. But his research suggests that police initially enforce such laws, then inevitably turn to other issues—and beggars return to the streets.

Another tactic to reduce begging is "diverted giving." There's a common perception that beggars use handouts for drugs and booze. So in cities like Baltimore and Denver, folks can drop coins in converted parking meters; the money goes to homeless charities. But beggars aren't all substance abusers. In a seminal 2001 U.K. survey, 45 percent cited food as their main purchase; 37 percent said drugs.

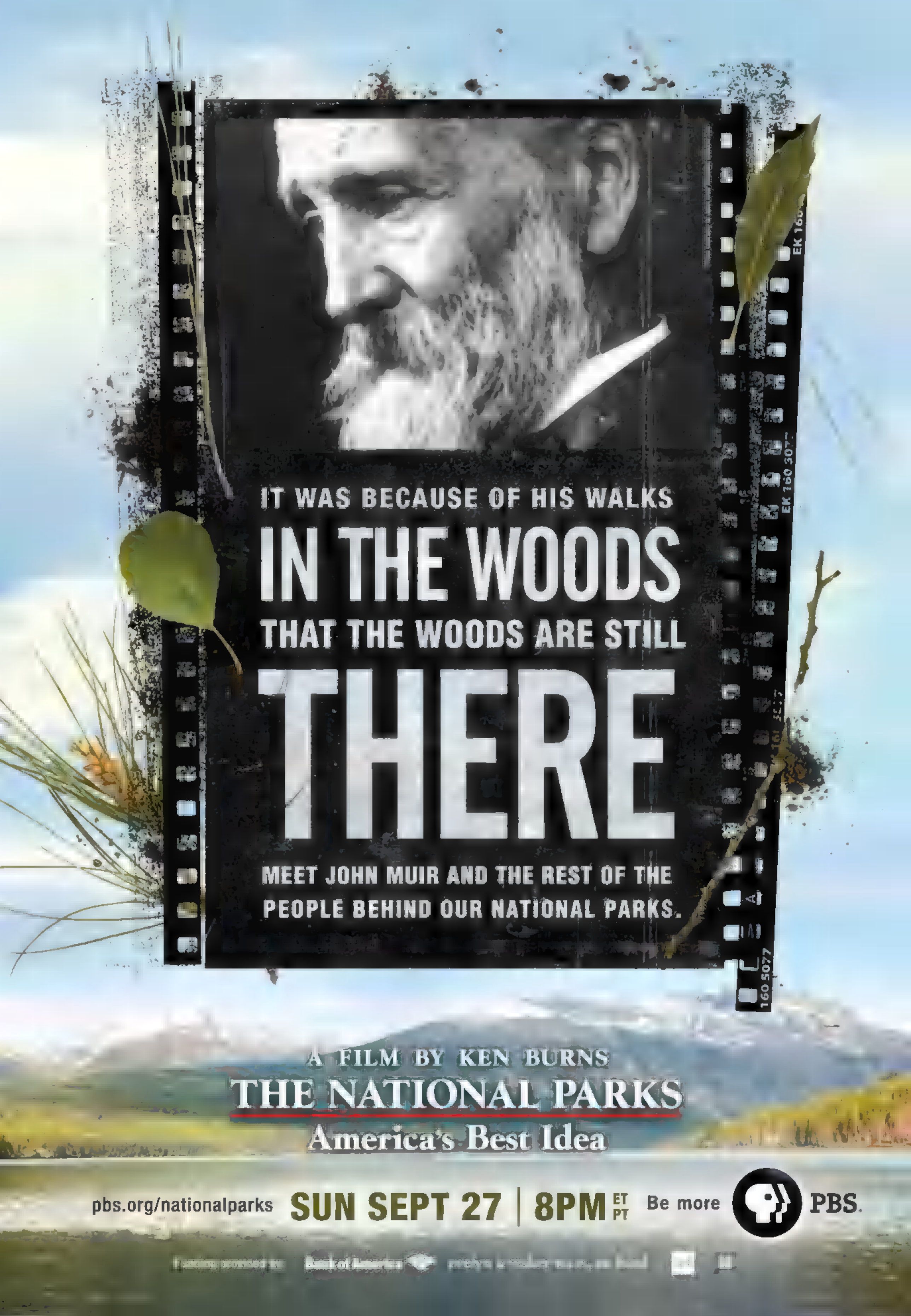
Meanwhile, parking-meter altruism doesn't help everyone figure out how to react to a lonely, outstretched hand. "Sometimes I give, sometimes I don't," admits Ed Shurna, a Chicago advocate for the homeless. "But my philosophy is that I always say hello." *—Marc Silver*

BEGGING LAWS
Here are some methods used to reduce begging.

- **Ireland** A new law targets beggars who threaten violence, beg repeatedly in one place, or use children as props.
- **India** Motorists can be fined if they give to beggars at traffic lights.
- **United States** Denver's "sit and lie" law says people can't block sidewalks. The police give warnings; outreach workers offer help. Arrests are a last resort.

Panhandlers, like this one in New York City, are a small but highly visible segment of the homeless.

PHOTO: LYNN JOHNSON


IT WAS BECAUSE OF HIS WALKS
IN THE WOODS
THAT THE WOODS ARE STILL
THERE
MEET JOHN MUIR AND THE REST OF THE
PEOPLE BEHIND OUR NATIONAL PARKS.
A FILM BY KEN BURNS
THE NATIONAL PARKS
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PBS.

Who's Number Two? Most folks know the cheetah's top speed of 70 mph makes it the fastest land animal. But what's the runner-up? Turns out it's the pronghorn. The deerlike mammal cruises at 35 mph and can hit 50. Its velocity is thought to have been a defense against cheetahs that lived in North America eons ago. Often overlooked, number twos can show how close the race is—or how far ahead a number one really is. *—Melody Kramer*

Second tallest animal
African elephant (#1: Giraffe)

The heaviest land mammal is the second tallest. Males grow to about 12 feet, females hit 9 feet. But at 15 to 19 feet tall, a grown giraffe could eat beans off an elephant's head.

Second tallest structure
KVLY TV mast, North Dakota
(#1: Burj Dubai building, 2,320 feet now; 2,600 is the goal)

The 2,063-foot-tall transmitting tower was completed in 1963. The FCC now suggests topping towers off at 2,000 feet for aircraft safety.

Second highest point on Earth
K2 (#1: Everest, 29,035 feet)

Dubbed Savage Mountain, the 28,251-foot K2 is one of the deadliest for climbers, with 77 fatalities.

Second deepest spot on Earth
Tonga Trench (#1: Mariana Trench)

In the duel of Pacific depressions, 35,837-foot Tonga is 400 feet shallower. It is the only trench holding a generator jettisoned by Apollo 13.

Second largest metropolitan area
New York City-Newark, 19.04 million
(#1: Tokyo, 36 million)

Look out, Big Apple. By 2025, you'll probably be trailing Mumbai, Delhi, São Paolo, Dhaka, and Mexico City.

Second least populous state
Tuvalu, 12,177 citizens
(#1: Vatican City, 824)

The Pacific island nation is just a sixth the size of Washington, D.C.

Second most popular tourist destination
Spain, 59.2 million visitors in 2007
(#1: France, 81.9 million)

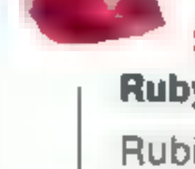
Second most widely spoken language as a first language
Hindi, 366 million
(#1: Mandarin Chinese, 873 million)

Second closest living human relative
Gorilla (#1: Chimpanzee)

Humans and chimps split from a common ancestor about seven million years ago. Gorillas and humans split some three million years before that.

Second smallest planet
Mars (#1: Mercury)

The red planet was bumped from #3 to #2 after astronomers stripped Pluto, previously the solar system runt, of planetary status.



Second hardest gemstone
Ruby/sapphire (#1: Diamond)

Rubies and sapphires are variations of the mineral corundum, which is also used in sandpaper.

Second longest river
Amazon (#1: Nile)

Or is it the other way round? The debate goes on. Traditional stats: Nile, 4,241 miles; Amazon, 4,000.

Second longest fish
Basking shark (#1: Whale shark)

It can reach 30 feet; a whale shark can grow to 40 to 60 feet.

Second shortest fish
Stout infantfish (#1: Adult male spiny-headed devilfish, .24 inch)

A mature stout infantfish is .27 inch. But even runners-up can prevail. Till other wee fry are weighed, the infantfish is the lightest fish: 500,000 to a pound.

PHOTOS (CLOCKWISE FROM TOP LEFT): RICHARD DU TOIT, MINDEN PICTURES/NG STOCK; MARK THIESSEN, NG PHOTOGRAPHER; CLAUS MEYER, MINDEN PICTURES/NG STOCK; MICHAEL POLIZA, NG STOCK. RUBY COURTESY PAMPILLONIA JEWELERS

THE LAWS OF GRAVITY DON'T APPLY TO EUPHORIA.

WARREN MAXIM'S NATURE VALLEY. WARREN MAXIM'S NATURE VALLEY BAR.
WHERE'S YOURS?™

THE TASTE NATURE INTENDED.®
naturevalley.com

The four-foot-tall muskox's stumpy legs and shaggy hair can make maneuvering difficult in deep snow.

NG GRANT Where Muskoxen Roam The muskox may look otherworldly, but it's very much a creature of the Earth. In fact, this 800-pound primal relative of sheep and goats has roamed the Arctic for about a million years, since the Pleistocene. Scientists want to make sure it stays around for a long time to come.

Some conservationists fear that certain muskox populations, particularly in the southern ranges (see map), could be imperiled by climate change. Wet winters can spell trouble if deep snow and ice restrict access to food. Warm autumns can mean disease or inhospitable habitat. All this can cause problems with reproduction.

In Alaska, where the native species died out in the 19th century, reintroduction has been mostly successful. Some 4,300 of the world's 150,000 muskoxen now live there. But in the Arctic National Wildlife Refuge, numbers have plunged by 50 percent in the past decade. Wildlife Conservation Society biologist and NG grantee Joel Berger has begun tracking Alaska muskoxen with GPS collars to see where else they may be vulnerable, and why. He says room to roam is one key to their survival, so that they can continue to leave areas that don't sustain them. In other words, more open space could buy these Ice Age survivors more time. *—Hannah Bloch*

PHOTO: STAFFAN WIDSTRAND, CORBIS NGM MAPS
SOURCE: PAMELA GROVES, UNIVERSITY OF ALASKA FAIRBANKS

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GOOD Decisions

#5 in a Series

Pablo CORRAL VEGA

PHOTOGRAPHY'S Soul

> "We are the sum of our encounters with others."

The day Pablo Corral Vega obtained his law degree, he was struck by the sense he had made a mistake. "I became increasingly frustrated because I didn't want to sit behind a desk. All I wanted was to see the world," says Corral Vega, who has since published six books of photography and is commissioned by magazines throughout the world.

Earlier in his work, Corral Vega, who is a native of Ecuador, concentrated on Latin American landscapes. Once again mindful of his inner voice, he made the good decision to refocus his lens on the people around him. "It was really a turning point. I was very shy and didn't know I could approach people," he says. However, even for the best of photographers, shooting human subjects isn't easy. "With people you have to deal with emotions, you have to wear the shoes of the other person." But the bravery of intimacy has been worth it. "You have to be vulnerable, you need to expose yourself, and you have to be open. We are who we are because of our contact with others."

In that spirit, Corral Vega has proudly created *nuestramirada.org*, a networking site for more than 1,000 photojournalists in Latin America, to help them grow in their profession. "I've had many opportunities in my photography career, and I would love for people to have the same chances I had. Anything we receive is a gift, and it should be given back."

Photographs made possible by NATIONAL GEOGRAPHIC Image Collection

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WHERE IN THE WORLD?

Nevada's Black Rock City shapes up as a semi-circle (for better desert views) with a five-sided security fence.

Instant City For eight days a year Black Rock City becomes one of Nevada's biggest towns, with a population rivaling that of the capital, Carson City. It even has an airport and department of motor vehicles. The ad hoc municipality arises in the Black Rock Desert to host 50,000 campers who attend the Burning Man counterculture festival the week before Labor Day. The event began in 1986 as a San Francisco art experiment cum beach party and moved to the desert in 1991 as crowds grew. Despite Burning Man's tradition of nudity and drugs, police make few arrests. At the center of the five-square-mile city is a 70-foot-tall wooden effigy, set ablaze at week's end. The town vanishes too, says founder Larry Harvey: "No roads, no buildings, no trash—as if we were never there." *—Peter Gwin*

IKONOS SATELLITE IMAGE COURTESY GEOEYE

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Mushrooms like this specimen, genus *Sarcodon*, spew carbon dioxide. But as temperatures warm in the north, emissions drop.

Mushroom Breath Fungi that pop up in the forest are "like CO_2 chimneys," says researcher Steven Allison. Back in 2005 he measured the carbon dioxide emitted by mushrooms after their rootlike mycelia ate carbon from the soil. He was "shocked" by their output—and concerned, since CO_2 traps heat in the atmosphere.

Allison figured that as the planet warmed up, fungi would thrive, belching out even more CO_2. To test the theory, he and a colleague from the University of California, Irvine, built small greenhouses in a central Alaska forest, with soil half a degree Celsius warmer than in control plots. To his surprise, the greenhouse mushrooms fell dormant or died; the soil likely dried out too much for them. The failing fungi consumed less carbon; their CO_2 emissions diminished.

A drop in mushroom CO_2 can't make up for human releases: One exhaled breath equals about the amount ■ large mushroom exudes in an hour. And southern fungi might not act the same as the northern ones studied. Nonetheless, learning how ecosystems affect CO_2 levels is critical in predicting Earth's temperature rise. "Bacteria are the next frontier," Allison says. "They also eat carbon, but we're not sure how much or how fast." He aims to find out. *—Karen E. Lange*

PHOTO: DOUGLAS SMITH

IN THE NEW ENERGY FUTURE WE'LL NEED TO THINK THE IMPOSSIBLE IS POSSIBLE.

The world needs to tackle CO_2 emissions. Carbon Capture and Storage (CCS) technology aims to capture CO_2 and store it safely underground.

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To find out how Shell is helping prepare for the new energy future visit **www.shell.com/us**

The Sinkhole Truth Something was messing with Texas in May 2008. A dip in Daisetta, ■ tiny town near Houston, became a hole the size of two football fields, sucking trucks, trees, and buildings into its 250-foot-deep maw. Residents were shaken; scientists were left shaking their heads. "This exceeds anything I've seen or read about," says the U.S. Geological Survey's Mark Kasmarek.

Few sinkholes match Daisetta's drama, and the cause of most is debatable. But gradual or sudden, natural or human abetted, sinkholes can occur anywhere rocks can dissolve. Groundwater eating away at soil or bedrock, ■ cave roof collapsing, a company injecting chemicals into a salt dome—sinkhole recipes all.

Some countries, like Italy and Jamaica, are geologically primed for sinkholes. So is about a fifth of the U.S., notably limestone-rich Florida and salty Texas. But knowing where to look isn't the same as knowing when. As geophysicist Carlos Aiken says, "There's no early warning system." Nor is there a typical outcome. While some big holes have been turned into landfills, others, like Daisetta's, become lakes—and possible rest stops for migratory fowl. *—Jeremy Berlin*

HOW HOLES SINK IN

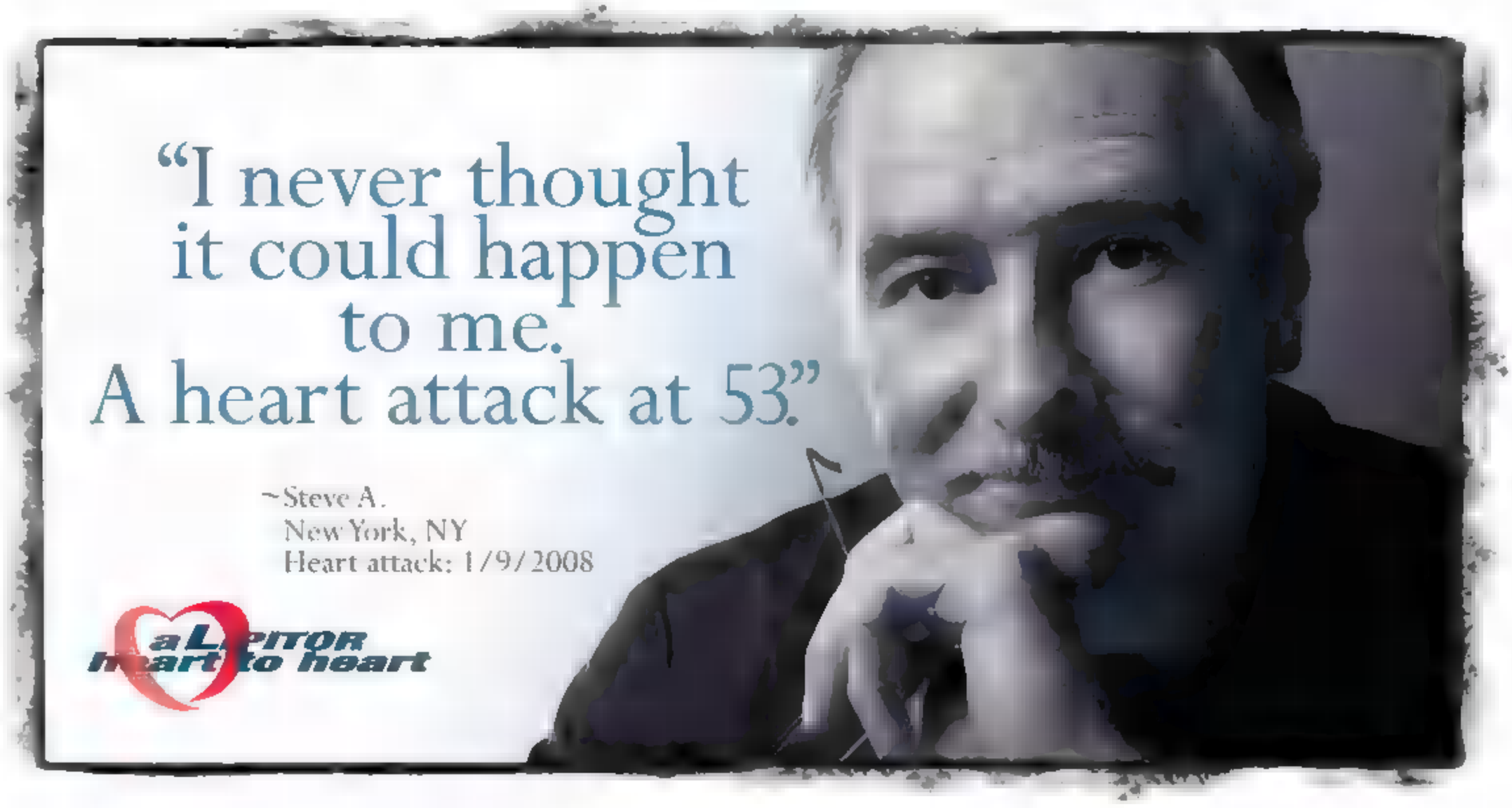
Cover-collapse sinkholes occur abruptly, often when an underground cavity gives way and surface clay falls in.

Cover-subsidence sinkholes develop gradually as sandy surface sediment falls into cavities in the bedrock below.

Dissolution sinkholes are similar to subsidence ones, except exposed bedrock wears away at the surface.

In 2007, a giant sinkhole in Guatemala City claimed three lives and swallowed several houses.

PHOTO: REUTERS



"I had been feeling fine. But turns out my cholesterol and other risk factors* increased my chance of a heart attack. Now I trust my heart to Lipitor. Talk to your doctor about your risk and about Lipitor."

- **Adding Lipitor may help, when diet and exercise are not enough. Unlike some other cholesterol-lowering medications, Lipitor is FDA-approved to reduce the risk of heart attack and stroke in patients with several common risk factors, including family history, high blood pressure, low good cholesterol, age and smoking.**
- **Lipitor has been extensively studied with over 16 years of research. And Lipitor is backed by 400 ongoing or completed clinical studies.**

*Patient's risk factors include age, gender, smoking, and high blood pressure.

IMPORTANT INFORMATION: LIPITOR is a prescription drug. It is used in patients with multiple risk factors for heart disease such as family history, high blood pressure, age, low HDL ('good' cholesterol) or smoking to reduce the risk of heart attack, stroke and certain kinds of heart surgeries. When diet and exercise alone are not enough, LIPITOR is used along with a low-fat diet and exercise to lower cholesterol.

LIPITOR is not for everyone. It is not for those with liver problems. And it is not for women who are nursing, pregnant or may become pregnant. If you take LIPITOR, tell your doctor if you feel any new muscle pain or weakness. This could be a sign of rare but serious muscle side effects. Tell your doctor about all medications you take. This may help avoid serious drug interactions.

Your doctor should do blood tests to check your liver function before and during treatment and may adjust your dose. The most common side effects are gas, constipation, stomach pain and heartburn. They tend to be mild and often go away.

LIPITOR is one of many cholesterol-lowering treatment options that you and your doctor can consider.

Please see additional important information on next page.

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IMPORTANT FACTS

LIPITOR atorvastatin calcium tablets (LIP-ih-tore)

LOWERING YOUR HIGH CHOLESTEROL

High cholesterol is more than just a number, it's a risk factor that should not be ignored. If your doctor said you have high cholesterol, you may be at an increased risk for heart attack. But the good news is, you can take steps to lower your cholesterol.

With the help of your doctor and a cholesterol-lowering medicine like LIPITOR, along with diet and exercise, you could be on your way to lowering your cholesterol.

Ready to start eating right and exercising more? Talk to your doctor and visit the American Heart Association at www.americanheart.org.

WHO IS LIPITOR FOR?

Who can take LIPITOR:

- People who cannot lower their cholesterol enough with diet and exercise
- Adults and children over 10

Who should NOT take LIPITOR:

- Women who are pregnant, may be pregnant, or may become pregnant. LIPITOR may harm your unborn baby. If you become pregnant, stop LIPITOR and call your doctor right away.
- Women who are breast-feeding. LIPITOR can pass into your breast milk and may harm your baby.
- People with liver problems
- People allergic to anything in LIPITOR

BEFORE YOU START LIPITOR

Tell your doctor:

- About all medications you take, including prescriptions, over-the-counter medications, vitamins, and herbal supplements
- If you have muscle aches or weakness
- If you drink more than 2 alcoholic drinks a day
- If you have diabetes or kidney problems
- If you have a thyroid problem

ABOUT LIPITOR

LIPITOR is a prescription medicine. Along with diet and exercise, it lowers "bad" cholesterol in your blood. It can also raise "good" cholesterol (HDL-C).

LIPITOR can lower the risk of heart attack or stroke in patients who have risk factors for heart disease such as:

- age, smoking, high blood pressure, low HDL-C, heart disease in the family, *or*
- diabetes with risk factor such as eye problems, kidney problems, smoking, or high blood pressure

POSSIBLE SIDE EFFECTS OF LIPITOR

Serious side effects in a small number of people:

- **Muscle problems** that can lead to kidney problems, including kidney failure. Your chance for muscle problems is higher if you take certain other medicines with LIPITOR.
- **Liver problems**. Your doctor may do blood tests to check your liver before you start LIPITOR and while you are taking it.

Symptoms of muscle or liver problems include:

- Unexplained muscle weakness or pain, especially if you have a fever or feel very tired
- Nausea, vomiting, or stomach pain
- Brown or dark-colored urine
- Feeling more tired than usual
- Your skin and the whites of your eyes turn yellow

If you have these symptoms, call your doctor right away.

The most common side effects of LIPITOR are:

- Headache
- Diarrhea, gas
- Rash
- Constipation
- Upset stomach and stomach pain
- Muscle and joint pain

Side effects are usually mild and may go away by themselves. Fewer than 3 people out of 100 stopped taking LIPITOR because of side effects.

HOW TO TAKE LIPITOR

Do:

- Take LIPITOR as prescribed by your doctor.
- Try to eat heart-healthy foods while you take LIPITOR.
- Take LIPITOR at any time of day, with or without food.
- If you miss a dose, take it as soon as you remember. But if it has been more than 12 hours since your missed dose, wait. Take the next dose at your regular time.

Don't:

- Do not change or stop your dose before talking to your doctor.
- Do not start new medicines before talking to your doctor.
- Do not give your LIPITOR to other people. It may harm them even if your problems are the same.
- Do not break the tablet.

NEED MORE INFORMATION?

- Ask your doctor or health care provider.
- Talk to your pharmacist.
- Go to **www.lipitor.com** or call **1-888-LIPITOR.**

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Acrocirrid worm

Oceanographers think the steep-sided Celebes Sea, 20,000 feet deep in places, may harbor dozens of new species in its depths.

Under the Celebes Sea When scientists dispatched a remotely operated vehicle to nose around the depths of the Celebes Sea, one of the world's most biologically diverse zones, they were prepared for surprises. Still, mouths dropped at the sight of the "squidworm" (above), as they dubbed this extraordinary invertebrate. Unlike many marine worms—small, drab creatures buried in the seafloor—this was a big, flashy extrovert, swimming in pitch-black waters 1.75 miles deep. From its head jutted feeding and breathing tentacles like ■ squid's; from its four-inch-long body projected bristles, propelling it like paddles.

Research by Karen J. Osborn at the Scripps Institution of Oceanography confirms that it's a new, still scientifically unnamed species of the bristle worm group. In addition to a half dozen squidworms, other keepers from the expedition—cosponsored by *National Geographic*, the National Oceanic and Atmospheric Administration, and the Woods Hole Oceanographic Institution, in cooperation with the Philippine government—include spiderlike crustaceans and ■ black comb jelly. With only ■ fraction of the Celebes Sea explored, plenty of other wondrous new creatures surely wait in the dark. *–Tom O'Neill*

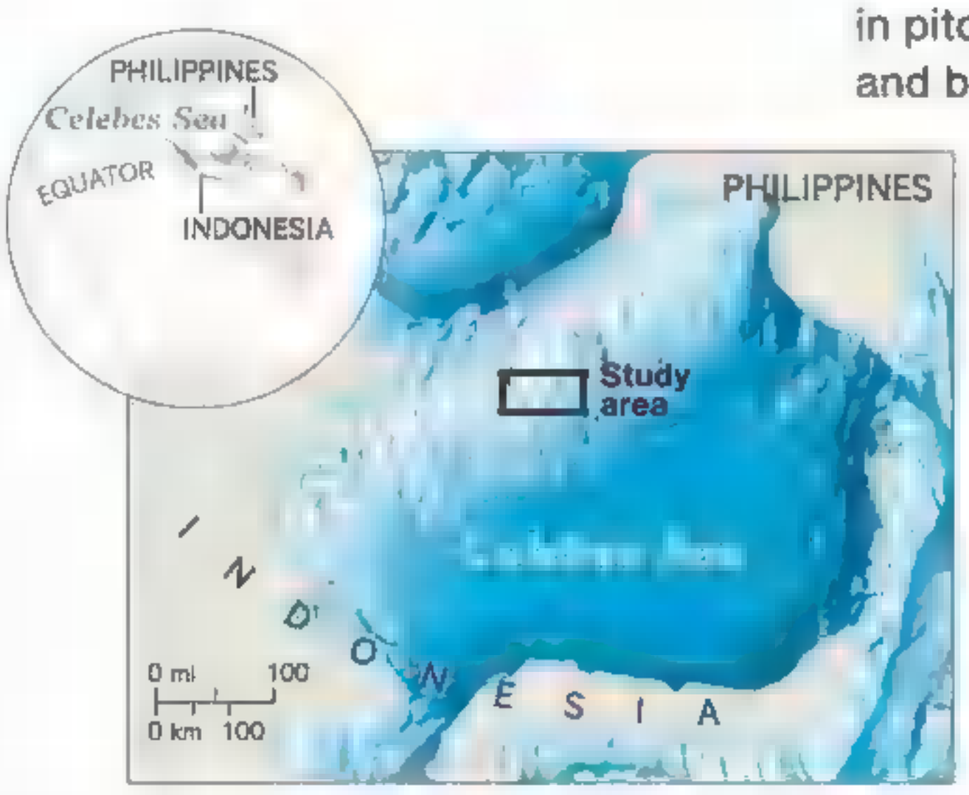

PHOTO: MICHAEL AW NGM MAPS

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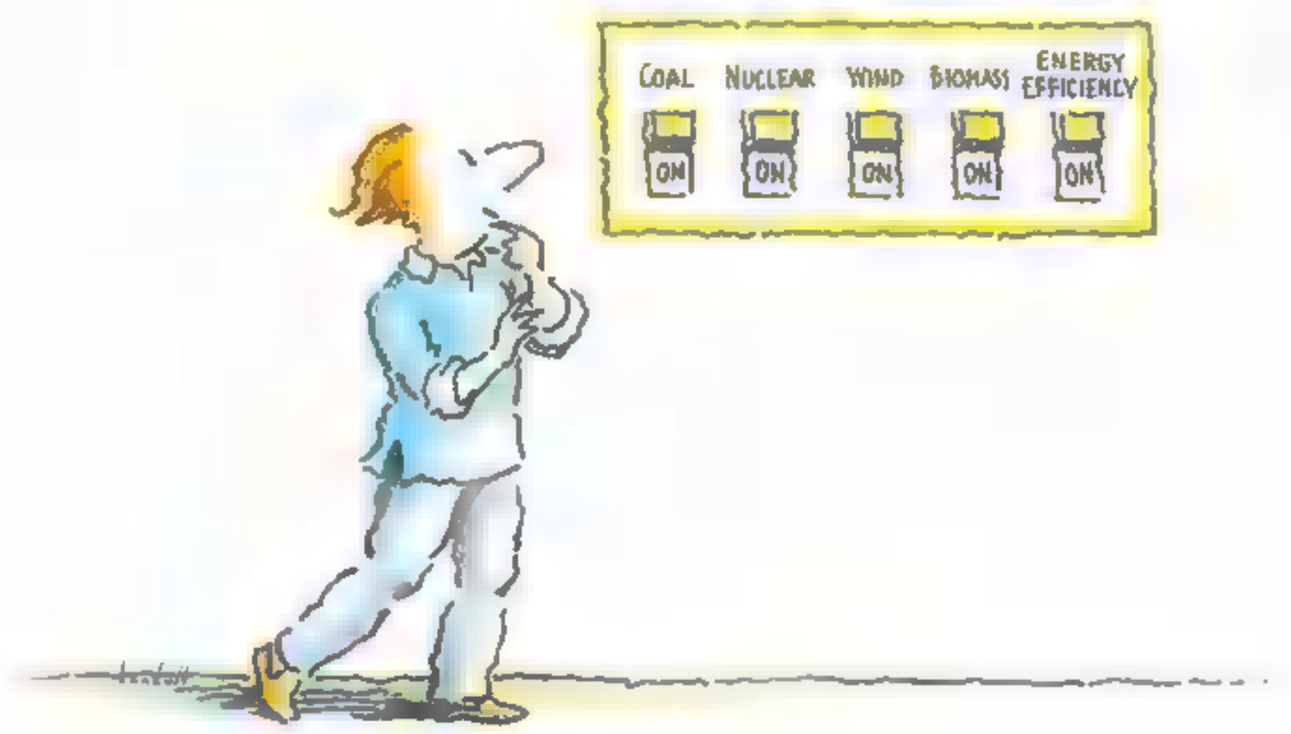

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Time travel at the speed of a 1935 Speedster?

The 1930s brought unprecedented innovation in machine-age technology and materials. Industrial designers from the auto industry translated the principles of aerodynamics and streamlining into everyday objects like radios and toasters. It was also a decade when an unequaled variety of watch cases and movements came into being. In lieu of hands to tell time, one such complication, called a jumping mechanism, utilized numerals on a disc viewed through a window. With its striking resemblance to the dashboard gauges and radio dials of the decade, the jump hour watch was indeed "in tune" with the times!

The Stauer *1930s Dashtronic* deftly blends the modern functionality of a 21-jewel automatic movement and 3-ATM water resistance with the distinctive, retro look of a jumping display (not an actual jumping complication). The stainless steel 1 1/2" case is complemented with a black alligator-embossed leather band. The band is 9 1/2" long and will fit a 7–8 1/2" wrist.

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From Africa to Astoria by way of everywhere

DNA from a single New York melting pot records the prehistoric migrations that peopled the planet.

FORKING PATHS through prehistory—and branches of the human family tree—are revealed by DNA mutations in 193 volunteers sampled in Astoria, Queens. Mutations known to have arisen in certain times and regions act as wayside markers tracing at least some of a participant's ancient geographic heritage. Four participants are highlighted here; the Queens group as a whole is representative of most, but not all, of the paths our prehistoric ancestors followed as they migrated out of Africa.

120,000 years ago | 100,000 | 80,000 | 60,000

Pedro Aguilar

Dotted lines represent the genetic histories of the four highlighted volunteers (photographs, far right).

Colors represent regions; branch thickness indicates how many of the 193 volunteers had ancestors from each region.

Alma Mujezinovic

Atsushi Mizukami

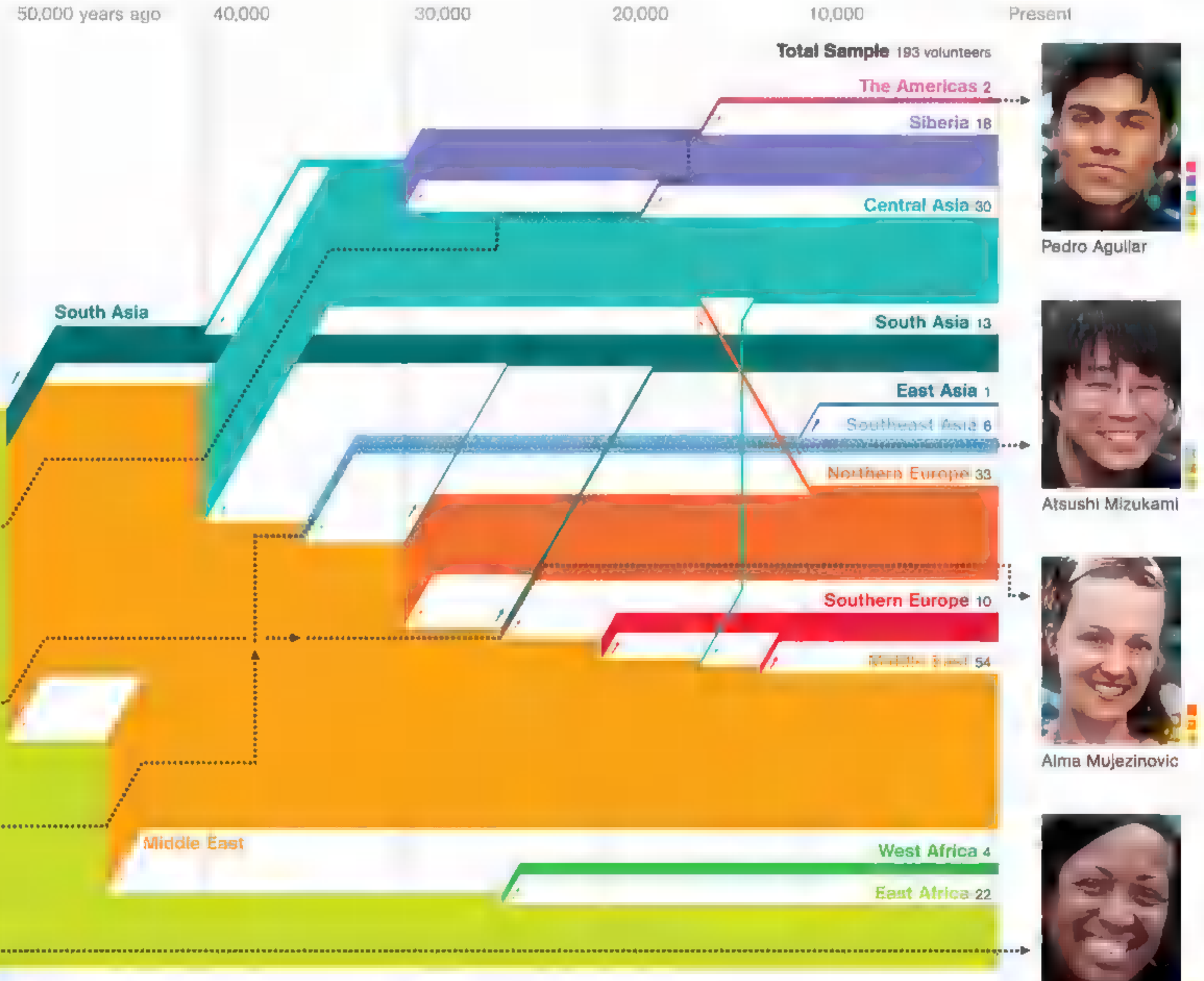
Michelle Brown-Johnston

1 All the participants in Queens, like the rest of us, can trace their earliest ancestors to East Africa—the green trunk of the human family tree.

The Astoria section of Queens, New York, is one of the most ethnically diverse communities on Earth. At the 30th Avenue Street Festival in July 2008, people of all heritages and complexions mingled among booths offering up Thai charms and Peruvian sweaters, Mexican corn and Italian *zeppole.* The sun was hot, the mood merrily multicultural. Through the crowd walked a tall, blond man with pale skin rapidly turning red. He stopped occasionally to talk to people, and if he found them obliging, asked if they could spare a few cells from the inside of their cheeks.

For the past four years Spencer Wells and his colleagues with National Geographic and IBM's Genographic Project have been traveling the globe, collecting DNA in cheek swabs and blood samples from hundreds of indigenous groups. By comparing their DNA, the project has been retracing the ancient history of human migrations since our species originated in Africa some 200,000 years ago.

The Genographic Project focuses on the Y chromosome in males, which is handed down intact from father to son, and on mitochondrial DNA (mtDNA), which a mother passes to her offspring. Over generations, small, harmless mutations accumulate on these two snippets of DNA; to Wells and other scientists these genetic markers constitute a history book. As ancient human populations migrated out of Africa,



2 Four-fifths have lineages that traversed the Middle East.

3 Most of those lineages branched into other regions before arriving, much more recently, in Queens.

GRAPHIC: OLIVER UBERTI AND M. BRODY DITTEMORE, NG STAFF
PHOTOS: STEVE WINTER

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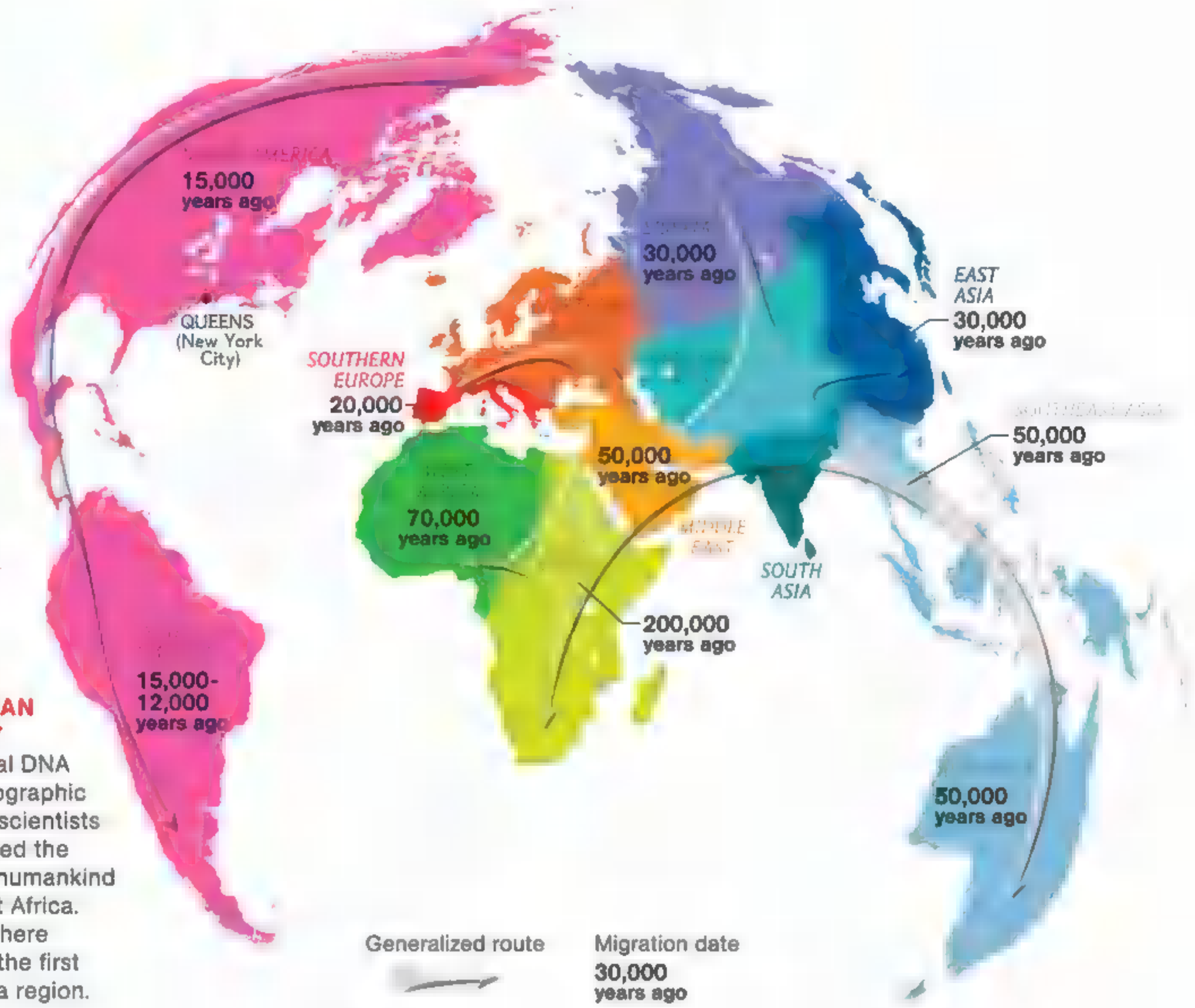


THE HUMAN JOURNEY
From global DNA data, Genographic and other scientists have charted the spread of humankind out of East Africa. The dates here represent the first arrivals in a region.

splitting off from each other and entering new lands, they accumulated different patterns of markers that reflect that history. Each individual today retains such a pattern.

In recent centuries those prehistoric paths have reconnected in New York and other immigrant havens. "From the beginning of the project," Wells says, "I've wondered if it would be possible to sample all the major lineages on Earth on a single street." On 30th Avenue he almost did—the 193 volunteers turned out to be carrying genetic markers for virtually all the major migrations that peopled the continents. The only missing lineage was the oldest one, which Genographic scientists found in Khoisan hunter-gatherers in southern Africa; their ancestors initially diverged from other modern humans more than 100,000 years ago.

The DNA of small, relatively unmixed groups like the Khoisan still preserves clear signals of their unique population histories. In places like Queens, where people from around the world have been swapping DNA for generations, those histories are being lost; a Y chromosome, say, doesn't reflect the whole ancestry of its owner, let alone of a population. If the Genographic Project usually targets populations that have so far escaped the melting pots, it's precisely because those pots are such a rich confusion of genes.

"Everybody talks about Astoria like its Greek," says George Delis, a retired community manager and ■ Greek immigrant himself. "Well, it's not Greek. It's everything." *—Jamie Shreeve*


Alisea Parikh

To learn more about human migrations and the Genographic Project, watch *The Human Family Tree* on the **National Geographic Channel, August 30 at 9 p.m. ET in the U.S.** Or click on the globe at **ngm.com/genographic.**

NGM MAPS. PHOTO: STEVE WINTER

PLUGGING INTO

THE SUN

SUNLIGHT BATHES US IN FAR MORE ENERGY THAN WE COULD EVER NEED—IF WE COULD JUST CATCH ENOUGH.

At an electric plant in southern Spain, mirrors as big as houses catch some of the 120 quadrillion watts of sunlight that constantly fall on Earth. Government subsidies for this pricey yet promising power source have made Europe the world's solar capital.

Turning unused space into a power source for 1,300 homes, Southern California Edison contractors cover a 14-acre warehouse roof near Los Angeles with some 25,000 lightweight photovoltaic, or PV, panels. California law requires utilities to generate 20 percent of their power from renewable sources by 2010.


ELECTR
ELECT

BY GEORGE JOHNSON

PHOTOGRAPHS BY MICHAEL MELFORD

Early on a clear November morning in the Mojave Desert, the sun is barely touching the peaks of the McCullough Range with a cool pink glow. Behind them, a full moon is sinking over the gigawatt glare of Las Vegas. Nevada Solar One is sleeping. But the day's work is about to begin.

It is hard to imagine that a power plant could be so beautiful: 250 acres of gently curved mirrors lined up in long troughs like canals of light. Parked facing the ground overnight, they are starting to awaken—more than 182,000 of them—and follow the sun.

"Looks like this will be a 700-degree day," says one of the operators in the control room. His job is to monitor the rows of parabolically shaped mirrors as they concentrate sunlight on long steel pipes filled with circulating oil, heating it as high as 750 degrees Fahrenheit. From the mirror field, the blistering liquid pours into giant radiators that extract the heat and boil water into steam. The steam drives a turbine and dynamo, pushing as much as 64 megawatts onto the grid—enough to electrify 14,000 households or a few Las Vegas casinos. "Once the system makes steam, it's very traditional—industry-standard stuff," says plant manager Robert Cable, pointing toward a gas-fired power plant on the other side of Eldorado Valley Drive. "We get the same tools and the same parts as the place across the street."

When Nevada Solar One came on line in 2007, it was the first large solar plant to be built in the United States in more than 17 years. During that time, solar technology blossomed elsewhere. Nevada Solar One belongs to Acciona, a Spanish company that generates electricity here and sells it to NV Energy, the regional utility. The mirrors were made in Germany.

Putting on hard hats and dark glasses, Cable and I get into his pickup and drive slowly past row after row of mirrors. Men with a water truck are hosing down some. "Any kind of dust affects them,"

As the lights come on in Los Angeles, solar evangelist Larry Kazmerski models the latest in PV: bendy thin-film panels that fit so many places, says the National Renewable Energy Laboratory researcher, they could one day power whole cities. "This is going to be on every roof and building," Kazmerski says.

George Johnson is the author of The Ten Most Beautiful Experiments *and seven other books. Michael Melford is a regular contributor; his photos on Herod the Great appeared in the December 2008 issue.*

Cable says. At the far edge of the mirror field, we stop and step out of the truck for a closer look. To show how sturdy the glass is, Cable bangs it like a drum. Above his head, at the focal point of the parabola, the pipe carrying the oil is coated with black ceramic to soak up the light, and it's encased in an airless glass cylinder for insulation. On a clear summer day with the sun directly overhead, Nevada Solar One can convert about 21 percent of the sun's rays into electricity. Gas plants are more efficient, but this fuel is free. And it doesn't emit planet-warming carbon dioxide.

About every 30 seconds there is a soft buzz as a motor moves the mirrors a little higher; by midday they will be looking straight up. It's so quiet out here one can hardly fathom how much work is being done: Each of the 760 arrays of mirrors can produce about 84,000 watts—almost 113 horsepower. By 8 a.m. the oil coursing through the pipes has reached operating temperature. A white plume is spewing from a cooling stack. Half an hour later, the sound of the turbine inside the generating station has reached a high-pitched scream. Nevada Solar One is ready to go on line.

The optimists say solar power could become as economical and efficient as fossil fuels. The pessimists say they've heard all this before.

WITH A NEW ADMINISTRATION in Washington promising to take on global warming and loosen the grip of foreign oil, solar energy finally may be coming of age. Last year oil prices spiked to more than $140 a barrel before plunging along with the economy—a reminder of the dangers of tying the future to something as unpredictable as oil. Washington, confronting the worst recession since the 1930s, is underwriting massive projects to overhaul the country's infrastructure, including its energy supply. In his inaugural address President Barack Obama promised to "harness the sun and the winds and the soil to fuel our cars and run our factories." His 2010 budget called for doubling the country's renewable energy capacity in three years. Wind turbines and biofuels will be important contributors. But no form of energy is more abundant than the sun.

"If we talk about geothermal or wind, all these other sources of renewable energy are limited in their quantity," Eicke Weber, director of the Fraunhofer Institute for Solar Energy Systems, in Freiburg, Germany, told me last fall. "The total power needs of the humans on Earth is approximately 16 terawatts," he said. (A terawatt is a trillion watts.) "In the year 2020 it is expected to grow to 20 terawatts. The sunshine on the solid part of the Earth is 120,000 terawatts. From this perspective, energy from the sun is virtually unlimited."

There are two main ways to harness it. The first is to produce steam, either with parabolic troughs like the ones in Nevada or with a field of flat, computer-guided mirrors, called heliostats, that focus sunlight on ■ receiver on top of an enormous "power tower." The second way is to convert sunlight directly into electricity with photovoltaic (PV) panels made of semiconductors such as silicon.

Each approach has its advantages. Right now steam generation,

also known as concentrating solar or solar thermal, is more efficient than photovoltaic—a greater percentage of incoming sunlight is converted into electricity. But it requires acres of land and long transmission lines to bring the power to market. Photovoltaic panels can be placed on rooftops at the point where the power is needed. Both energy sources share an obvious drawback: They fade when it's cloudy and disappear at night. But engineers are already developing systems for storing the energy for use in the darker hours.

The optimists say that with steady, incremental improvements—no huge breakthroughs are required—and with substantial government support, solar power could become as economical and efficient as fossil fuels. The pessimists say they've heard all this before—30 years ago, during the presidency of Jimmy Carter. That too was a period of national crisis, triggered by the Arab oil embargo of 1973. Addressing the nation in his cardigan sweater, President Carter called for a new national energy policy with solar energy playing a large part. In 1979 the Islamic revolution in Iran sent oil prices soaring again. American drivers lined up for gasoline, their radios blaring songs like "Bomb Iran," by Vince Vance and the

RETRO SOLAR The energy of the future has a past. Shards of old mirrors (top) lie under their replacements at California's 25-year-old SEGS I, the first commercial solar thermal plant in the United States. A 1977 speech by President Jimmy Carter (above) heralded the first federal push for renewable energy. But it faltered after Carter left office and oil prices later plummeted.

CARTER PHOTO: MARION S. TRIKOSKO, LIBRARY OF CONGRESS PRINTS AND PHOTOGRAPHS DIVISION

SunCatchers at Sandia National Laboratories in New Mexico stand dormant at moonrise. At daybreak each mirror array will turn sunward, and concentrated light will heat a Stirling engine held at the focal point, driving pistons and making electricity. No system is more efficient at converting photons to grid-ready AC power. Stirling Energy Systems plans to erect some 60,000 SunCatchers at desert sites near Los Angeles and San Diego


SES

Valiants (sung to the tune of the Beach Boys' "Barbara Ann"). Carter, true to his word, put solar water heaters on the White House roof.

During the next few years, two large fields of parabolic troughs, SEGS I and II (for Solar Electric Generating Station) were installed about 160 miles southwest of Las Vegas, near Daggett, California. They were followed by seven more plants nearby, at Kramer Junction and beside waterless Harper Lake. The plants are still operating—about a million mirrors in all on some 1,600 acres with a combined power of 354 megawatts. From afar they look like mirages.

The momentum didn't last. As the economy adjusted to the Iranian oil shock, fuel prices fell. With the sense of urgency reduced, along with the research dollars, solar remained a minor factor in the energy equation. The SEGS plants were still being built when President Ronald Reagan took the solar water heaters off the White House roof. The first solar revolution fizzled.

Two decades later, a new solar revolution may be ready to begin.

If photovoltaic panels covered just three-tenths of a percent of the United States, a 100-by-100-mile square, they could power the entire country.

ANOTHER LEGACY OF THE CARTER ERA, the National Renewable Energy Laboratory (NREL) in Golden, Colorado—the government's primary research center for solar, wind, hydrogen, and other alternative fuels—is bracing for a resurgence. When I visited last fall, a new research campus and headquarters were under construction against the side of a mountain outside Golden. Five acres of photovoltaic panels on top of the mesa will feed the labs and offices below. That may be just the beginning. Once treated by the government as something of a stepchild, NREL is benefiting from the extra money the Obama Administration is devoting to renewable energy. "Right now solar is such a small fraction of U.S. electricity production that it's measured in tenths of a percent," said Robert Hawsey, an associate director of the lab. "But that's expected to grow. Ten to 20 percent of the nation's peak electricity demand could be provided by solar energy by 2030."

But not without government help (see story, page 52). Nevada Solar One would never have been built if the state had not set a deadline requiring utilities to generate 20 percent of their power from renewable sources by 2015. (More than two dozen states now have "renewable-portfolio standards," and earlier this year Congress was debating a federal one.) During peak demand—a hot afternoon in Las Vegas, when production costs are highest—the solar plant's electricity is almost as cheap as that of its gas-fired neighbor. But that's only because a 30 percent federal tax credit helped offset its construction costs.

Aiming to bring down costs and reduce the need for incentives, NREL's engineers are studying mirrors made from lightweight polymers instead of glass and receiving tubes that will absorb more sunlight and lose less heat. They're also working on solar power's biggest problem: how to store some of the heat produced during daylight

hours for release later on. "In the Southwest particularly, peak loads are in the daytime, but they don't end when the sun goes down," said Mark Mehos, an NREL program manager. People come home from work, turn on lights and air conditioners. Before long they may be plugging in electric cars.

Last year the first commercial solar plant with heat storage opened near Guadix, Spain, east of Granada. During the day, sunlight from a mirror field is used to heat molten salt. In the evening, as the salt cools, it gives back heat to make more steam. In Arizona the Solana Generating Station will also use molten salt for storage. When it goes on line in 2012, three square miles of parabolic troughs will produce 280 megawatts for Phoenix and Tucson. Solana is being built by a Spanish company, Abengoa Solar—an indication of just how far, in the development of this technology, the United States has fallen behind.

BACK IN THE 1980S, an engineer named Roland Hulstrom calculated that if photovoltaic panels—the other big solar technology—covered just three-tenths of a percent of the United States, a 100-by-100-mile square, they could electrify the entire country.

People thought he wanted to pave the Mojave with silicon. "The environmentalists got up in arms and said, You can't just go out and cover a hundred miles square," Hulstrom said recently as he sat in his office at NREL. But that's not what he meant. "You can cover parking lots with photovoltaic. You can put it on house roofs."

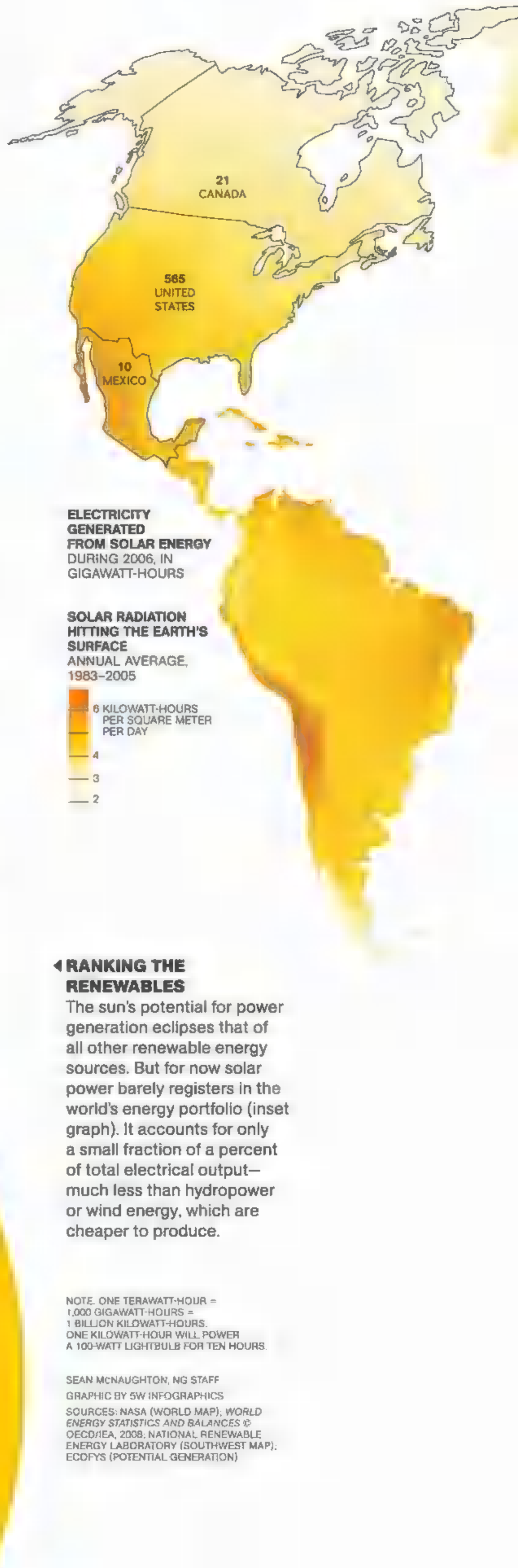
Twenty years later, PV panels still contribute only a tiny amount to the nation's electricity supply. But on rooftops in California, Nevada, and other states with good sunshine and tax incentives, they're a sight almost as familiar as air conditioners—and though not yet as developed as solar thermal, they may have a brighter future.

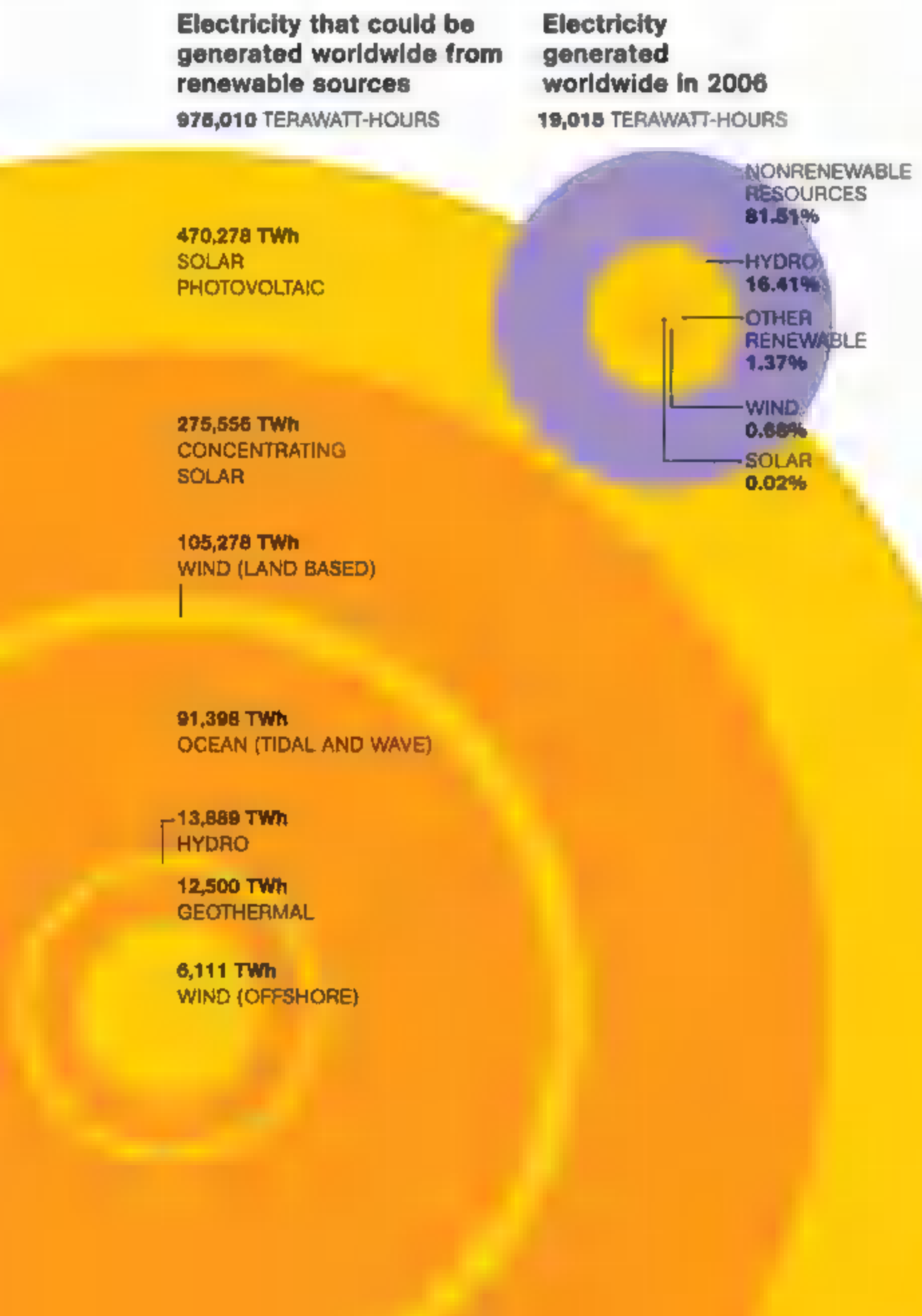
Right now the panels are expensive, and they provide an efficiency of only about 10 to 20 percent, compared with the 24 percent of parabolic troughs. History more than physics is to blame. After the solar bust in the mid-1980s, many of the best engineers migrated to the computing industry, which uses the same raw material—silicon and other semiconductors. Following what is called Moore's law, microprocessors doubled in capability every couple of years, while solar languished. Now some of the engineering talent is moving back to solar.

Researchers at NREL are exploiting the fact that different semiconductors capture different colors from a beam of sunlight. By layering compounds called gallium indium phosphide and gallium indium arsenide and using a lens to concentrate sunlight, they built a PV cell last year that is 40.8 percent efficient (a world record, since broken). But it's far from ready for mass production. "The technology is incredibly sophisticated," said Ray Stults, an associate director of the laboratory. "We can make it right now for $10,000

ENDLESS POTENTIAL

ENERGY EQUAL TO 6,000 TIMES the world's electricity use constantly shines on Earth. Even with current technology, we could harvest enough to supply dozens of times our demand for electricity—but building the infrastructure needed to switch to solar would cost much more at current prices than continuing to burn fossil fuels. As data from NASA satellites show (map, right), the world's solar leaders, notably Germany, are not the sunniest countries but the ones that can afford to pay extra for solar power. Solar costs are falling steadily, however. Developing nations in the subtropics may benefit from that trend; steady sunshine there means investment in solar infrastructure could pay off fast. Most of the world's best solar potential remains unexploited.





RANKING THE RENEWABLES

The sun's potential for power generation eclipses that of all other renewable energy sources. But for now solar power barely registers in the world's energy portfolio (inset graph). It accounts for only a small fraction of a percent of total electrical output—much less than hydropower or wind energy, which are cheaper to produce.

NOTE: ONE TERAWATT-HOUR = 1,000 GIGAWATT-HOURS = 1 BILLION KILOWATT-HOURS. ONE KILOWATT-HOUR WILL POWER A 100-WATT LIGHTBULB FOR TEN HOURS.

SEAN McNAUGHTON, NG STAFF

GRAPHIC BY 5W INFOGRAPHICS

SOURCES: NASA (WORLD MAP); *WORLD ENERGY STATISTICS AND BALANCES* © OECD/IEA, 2008; NATIONAL RENEWABLE ENERGY LABORATORY (SOUTHWEST MAP); ECOFYS (POTENTIAL GENERATION)

2,220 GERMANY
125 SPAIN
35 ITALY
35 NETHERLANDS
23 SWITZERLAND
22 FRANCE
21 LUXEMBOURG
15 AUSTRIA
21 SEVEN OTHER EUROPEAN COUNTRIES

Germany
Cloudy skies haven't stopped it from doggedly transforming itself into the global solar leader.

4 SENEGAL

2 ERITREA

532 SOUTH AFRICA

105 CHINA

19 INDIA

SOUTH KOREA 31

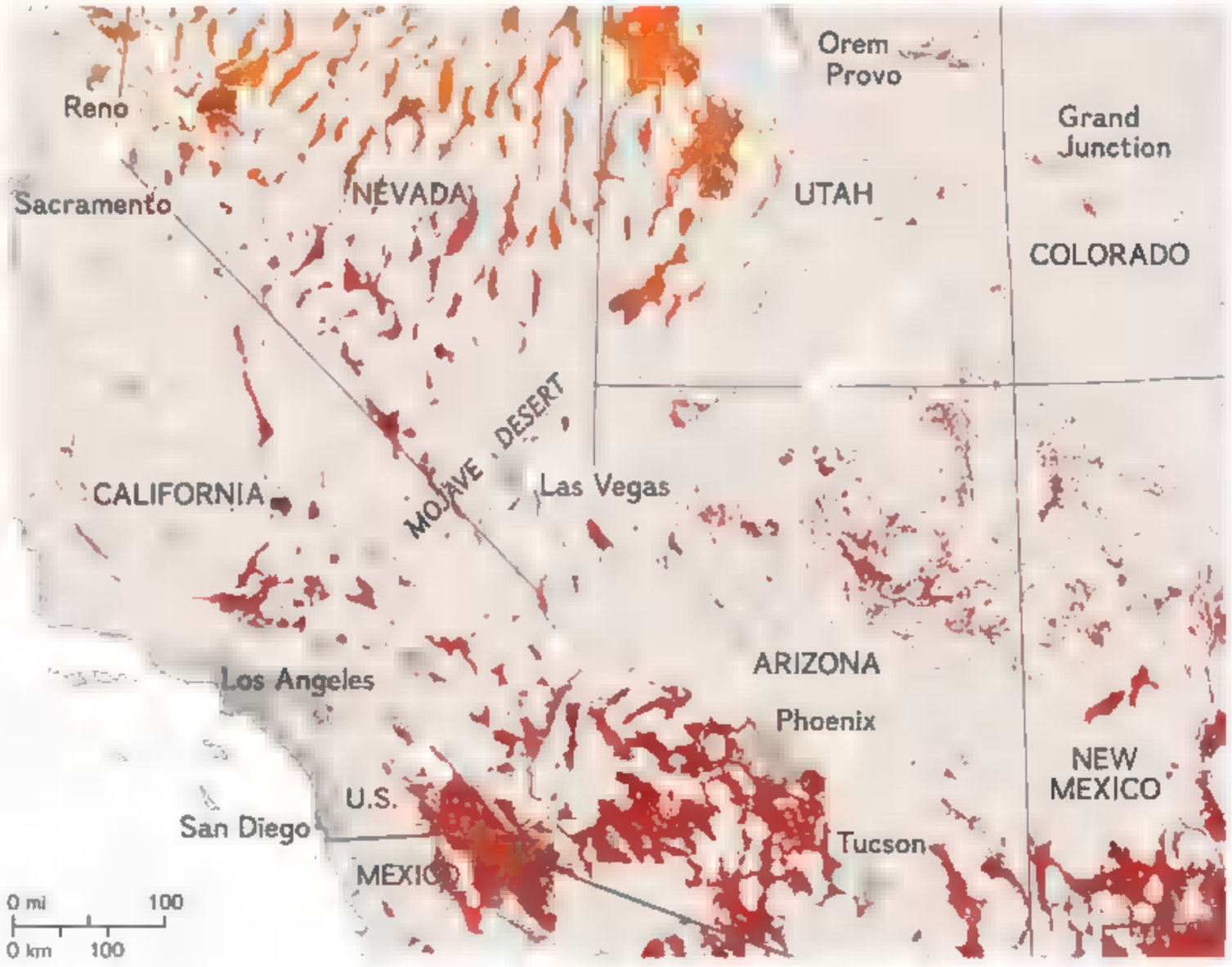
FOUR OTHER ASIAN COUNTRIES 5

China
It lags in generating solar electricity but has invested heavily in solar water heaters.

31 AUSTRALIA

THE SOLAR SOUTHWEST

Solar advocates say the desert Southwest could light the entire U.S. Thousands of square miles there (colored areas) are not only sunny but also flat and undeveloped enough for concentrating-solar plants. Some environmentalists oppose the land- and water-hungry projects and the new transmission lines that would be needed.



SOLAR RADIATION SUITABLE FOR USE IN CONCENTRATING-SOLAR PLANTS

8 KILOWATT-HOURS PER SQUARE METER PER DAY
7
6
POPULATED AREAS

per square centimeter, but not many people are going to buy it."

Another approach is to trade higher efficiency for lower cost. Though they generate less power per square inch, thin-film semiconductors require less raw material, making them a cheaper alternative for large photovoltaic installations. Two American companies, First Solar and Nanosolar, say they can now manufacture thin-film solar cells at a cost of around a dollar a watt—tantalizingly close to what's needed to compete with fossil fuels. Looking further ahead, engineers at NREL are working on photovoltaic liquids. "The goal there is to make it the cost of a gallon of paint," Stults said. "The efficiencies won't be 40 or 50 percent. They'll be 10 percent. But if it's cheap, you can paint your walls, hook it up, and go."

On some days 100 percent of Nellis Air Force Base is solar powered. No pipes, boilers, or dynamos—just photons knocking electrons off silicon.

Photovoltaic panels aren't limited to individual houses or warehouses. On the northeastern outskirts of Las Vegas, Nellis Air Force Base is supplying an average of 25 percent of its electricity with photovoltaic. On some winter days when there is no need for air-conditioning, 100 percent of the base is solar powered. Last fall, as I looked across the field of 72,416 sun-tracking panels, the wind blowing between the rows, I could see the appeal: There were no oil pipes, heat exchangers, boilers, dynamos, or cooling towers—just solar photons knocking electrons off silicon atoms and generating a current. Constructed in just 26 weeks in 2007 by the SunPower Corporation, the system generates 14.2 megawatts, making it the largest photovoltaic installation in the United States—though only about the 25th largest in the world. Nearly all the bigger ones are in Spain, which, like Germany, has invested heavily in solar power.

None of those plants yet include a storage system. Since photovoltaics produce electricity directly, there is no heat to capture in tanks of molten salt. One option would be to divert some of the photovoltaic current during the day to drive pumps, compressing air into underground caverns. Compressed air has been employed for decades in Germany and Alabama to store the cheaper nighttime output of conventional power plants for use during the daytime peak. At a solar plant the cycle would be reversed: When electricity was needed at night, the pent-up energy from the sunlit hours would be released, rushing forth and spinning a turbine.

Right now people who live off-grid with PV panels on their roofs rely on ordinary batteries to get through the night. In the future they might have solar-powered electrolyzers that split water molecules into hydrogen and oxygen. Recombining the gases in a fuel cell would yield electricity again. The idea is old, but last year Daniel Nocera, a chemist at MIT, reported what may be a breakthrough: a new catalyst that makes splitting water much cheaper. At public lectures Nocera likes to hold up a large plastic water bottle. All of a family's nighttime electricity requirements, he says, could be stored in five of these, with enough left over to run the electric car.

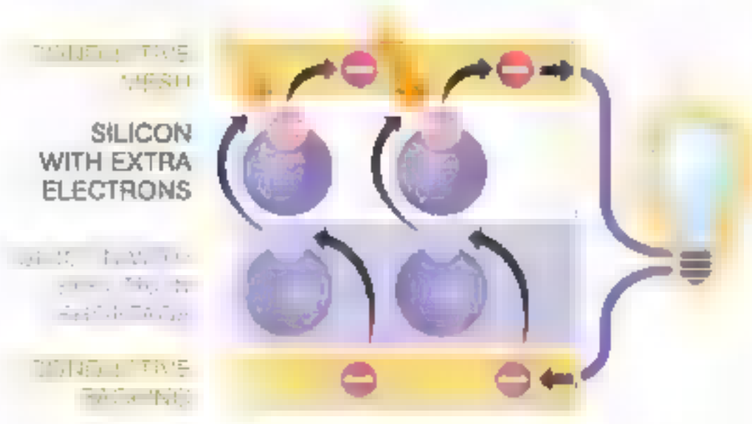
No one knows in detail the future of solar energy. But there is

a gathering sense that it is wide open—if we can make the commitment to jump-start the technology. "Originally it seemed like a pie-in-the-sky idea," Michelle Price, the energy manager at Nellis, told me last fall when I toured the base's new photovoltaic plant. "It didn't seem possible." Many things seem possible now.

ON A COLD DECEMBER MORNING west of Frankfurt, Germany, fog hung frozen in the trees, and clouds blocked the sun. Shivering on a ridge above the town of Morbach, I watched the blades of a 330-foot-high wind turbine swoop in and out of the gloom. Down below, a field of photovoltaic panels struggled for light. Who would have thought that Germany would transform itself into the largest producer of photovoltaic power in the world, with a capacity of more than five gigawatts?

A fraction of this power comes from centralized plants like the small one at Morbach or even the sprawling 272-acre Waldpolenz Solar Park, which was constructed recently with thin-film technology on an abandoned Soviet air base near Leipzig. With land at a premium in Germany, solar panels are mounted on rooftops,

PHOTOVOLTAIC POWER
Solar panels like these on roofs at ■ Bavarian farm produce electricity when light jars electrons loose in a semiconductor, often silicon (below). Unlike concentrating solar, the other strategy for generating solar electricity, PV systems can operate efficiently on ■ small scale.



GRAPHIC: 5W INFOGRAPHICS

Above a scorched plain outside Seville, Spain, reflected sunlight reflects again off low clouds. Ordinarily the mirrors at Abengoa Solar's PS10 station beam searing, concentrated light to the top of the "power tower," heating a boiler that makes steam to drive a turbine. On overcast days, operators aim the mirrors skyward; [illegible] sun through clouds could heat the tower so quickly it would be destroyed

farmhouses, even on soccer stadiums and along the autobahn. Though dispersed across the countryside, they are connected to the national grid, and utility companies are required to pay even the smallest producers a premium of about 50 euro cents a kilowatt-hour.

"We are being paid for living in this house," said Wolfgang Schnürer, a resident of Solarsiedlung—"solar settlement"—a condominium complex in Freiburg. Outside, snow was sliding off the solar panels that covered the roofs of the development. The day before, Schnürer's system had produced only 5.8 kilowatt-hours, not enough even for a German household. But on a sunny day in May it had yielded more than seven times that much.

At a time of economic calamity, the New Deal transformed the nation's energy landscape. Seven decades later we still reap the benefits every time we flip a switch.

After serving coffee and Christmas cookies, Schnürer spread some printouts on the table. In 2008 his personal power plant generated 6,187 kilowatt-hours, more than double what the Schnürers consumed. When the amount they used was subtracted from the amount they produced, they came out more than 2,500 euros (nearly $3,700) ahead.

Sitting at the edge of the Black Forest in the southern part of the country, "sunny Freiburg," as the tourist brochures call it, has been transformed by the solar boom. Across the street from Solarsiedlung, a parking garage and a school are covered with photovoltaic panels. In the older part of town, towering walls of photovoltaics greet visitors at the train station. Nearby, at the Fraunhofer Institute for Solar Energy Systems, the next generation of technology is being developed. In one project, Fresnel lenses are used to concentrate sunlight 500 times, raising the efficiency of a standard photovoltaic panel as high as 23 percent.

It is the demand created by the government's "feed-in tariff" that drives research like this, said Eicke Weber, the institute's director. Anybody who installs a photovoltaic system is guaranteed above-market rates for 20 years—the equivalent of an 8 percent annual return on the initial investment. "It is an ingenious mechanism," Weber said. "I always say the United States addresses the idealists, those who want to save the planet—the Birkenstock crowd. In Germany the law addresses anyone who wants to get 8 percent return on his investment for 20 years."

THE MOST SPECTACULAR SHOWCASE FOR the future of solar is probably Plataforma Solúcar, a Spanish solar energy complex on the Andalusian plains. I'd seen photographs of the 11-megawatt power tower called PS10. Rising 377 feet high, it is surrounded by 624 sun-tracking mirrors that reflect light beams toward its crown, igniting a glow that shines like a new star. Next to it, PS20 has since been completed with twice as many heliostats and double the power. But as I crested a hilltop about 15 miles west of Seville, I saw that the German weather had followed me. The valley was enveloped in fog—a reminder that even in torrid southern Spain, solar will

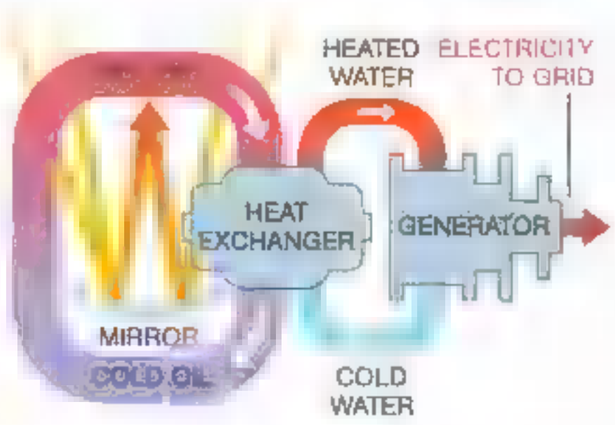
always have to be supplemented by storage and other forms of power.

"We had a problem last night—no more tower," said Valerio Fernández, director of the plant, which is owned by Abengoa Solar, as he met me at the gate. He laughed as we looked up at PS10, its head lost in the clouds. On a normal day, the power focused on the tower could reach four megawatts per square meter—far more than can be safely utilized. PS10's operators have to limit the flux to avoid melting the receiver.

Power towers are a different version of solar thermal, another way to use sunlight to make steam. Although parabolic troughs are well proven for large, flat areas, power towers can be fit to hilly terrain, the mirrors individually aligned to converge on the elevated boiler. Because a tower heats steam to higher temperatures, it is potentially more efficient.

With the solar industry still in its infancy, however, Abengoa Solar is hedging its bets. Not far from the power towers, cranes were assembling rows of parabolic troughs. Behind PS10 stretched a field of advanced photovoltaics that track the sun on two axes—north-south as well as east-west—to ensure optimal exposure throughout

CONCENTRATING SOLAR
At Nevada Solar One near Las Vegas, oil piped down long rows of reflectors soaks up focused sunlight, becoming hot enough to make steam and run ■ 64-megawatt power plant (below). Utilities often favor such systems, also called solar thermal, over costlier PV.

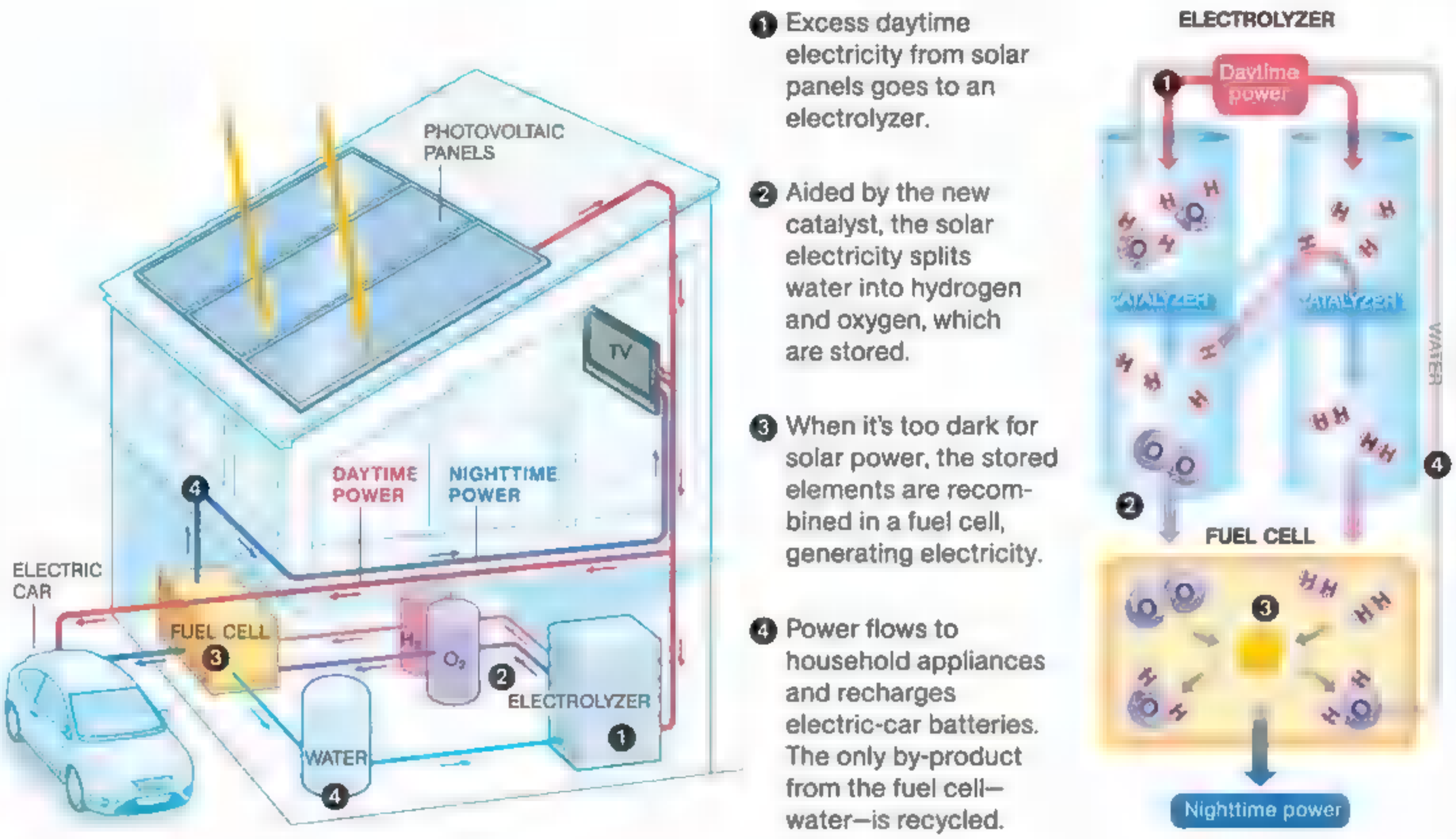


GRAPHIC: 5W INFOGRAPHICS

Stretching across terrain already gridded by Andalusian farms, Andasol 1 and 2 rely on the same energy source as the crops. Plants store solar energy via photosynthesis; these concentrating-solar facilities store it by using some of the sunlight they collect during the day to heat thousands of tons of salt. Tapping that heat after sunset allows them to generate electricity for 7.5 more hours.

HECTOR GARRIDO

SOLAR 24/7 Power after dark remains a challenge for the solar home. But a cheap, self-renewing catalyst discovered by MIT researcher Daniel Nocera (right) might allow water to act as a storage medium, keeping the lights on at night and even refueling an electric or hydrogen car. "Your house becomes a power plant," Nocera says. "It becomes a gas station."



the year. Each panel was fitted with mirrors or Fresnel lenses to intensify the light. "Taking profit from every one of the rays of sun—that's our goal," Fernández said.

BACK HOME IN THE UNITED STATES I read a magazine article challenging the country to move faster in harnessing the sun: "Every hour, it floods the earth with a deluge of thermal energy equal to 21 billion tons of coal," the writer had calculated. "The enormous output of solar energy is almost impossible to conceive." Illustrated with a drawing of a futuristic solar plant with enormous steam-generating mirrors, the article was entitled "Why Don't We Have…Sun Power?" It was dated September 1953.

This time we might just make it. Last February, BrightSource Energy signed contracts with Southern California Edison for a series of power towers in southwestern deserts that could eventually provide 1.3 gigawatts of power, equal to a large coal-fired plant. Meanwhile, Pacific Gas and Electric has commissioned more than 1.8 gigawatts of parabolic troughs, photovoltaics, and BrightSource power towers. Environmentalists are already preparing to fight some

GRAPHIC: 5W INFOGRAPHICS

of these projects; they would all cover large swaths of desert, and some might use a lot of scarce water for cooling. Like any form of power generation, solar has its trade-offs.

And it still has a long way to go. While I was in Nevada, I drove out to Hoover Dam—an early mass producer of renewable electricity—and joined a tour descending deep inside. At the bottom the torrent of Colorado River water falling from Lake Mead was spinning two parallel rows of giant turbines. Just one turbine puts out 130 megawatts, twice the power of Nevada Solar One.

But Hoover Dam left me feeling hopeful. Back on top, as I read the tarnished brass plaques and admired the art deco architecture, I thought about how this country had met the challenges of the Great Depression of the 1930s. The New Deal, as that earlier stimulus package was called, included not only Hoover but also the Tennessee Valley Authority, which brought hydroelectric power to the Southeast, and the Rural Electrification Administration, which strung power lines into the heartland. At a time of economic calamity, the nation's energy landscape was transformed. Seven decades later we still reap the benefits every time we flip a switch. □

CAN SOLAR SAVE US?

PROBABLY.

EVENTUALLY.

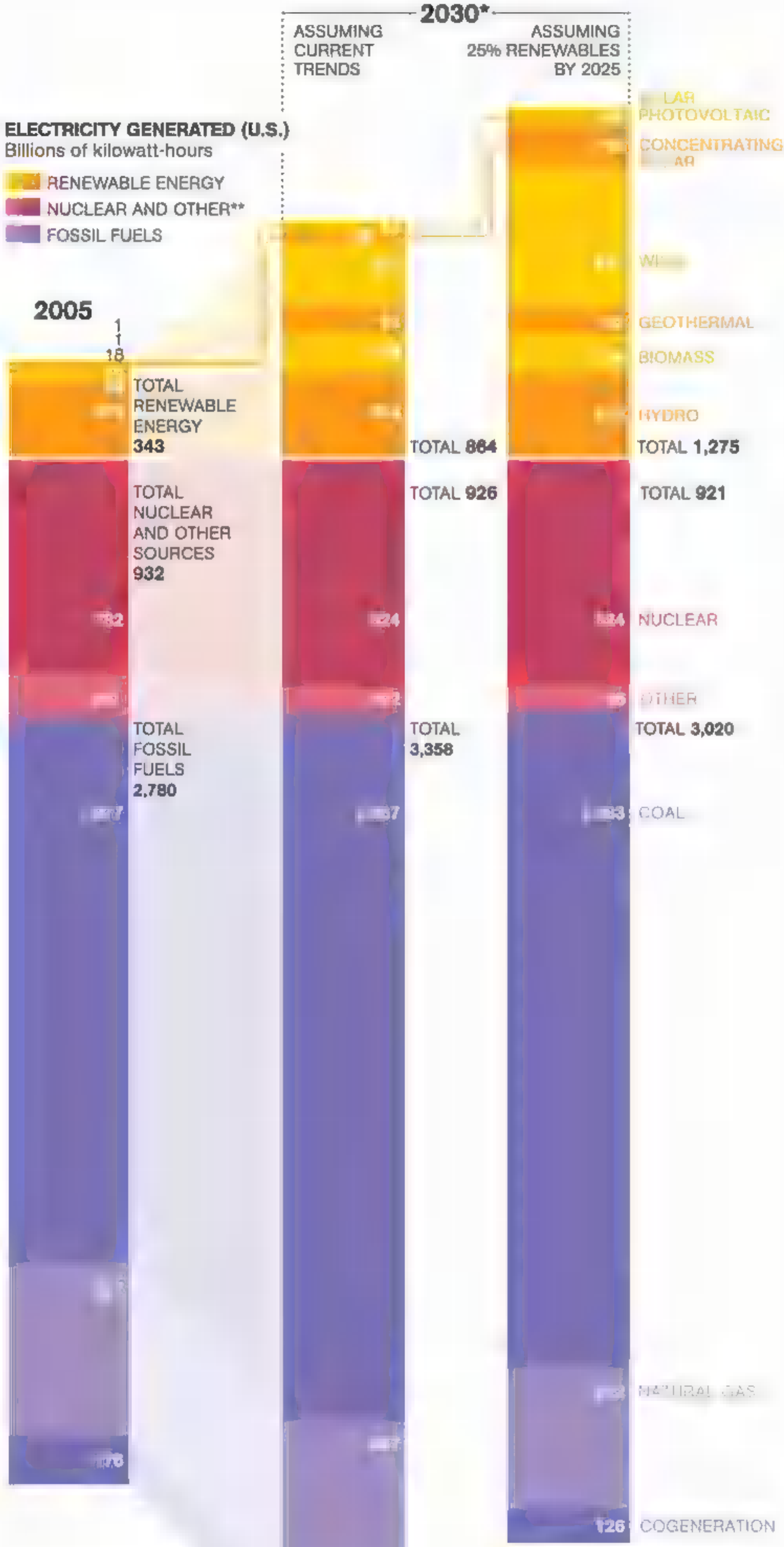
WITH LOTS OF GOVERNMENT HELP.

THE SUN IS A UTOPIAN FUEL: limitless, ubiquitous, and clean. Surely someday we'll give up on coal, oil, and gas—so hard on the climate, so unequally distributed worldwide—and go straight to the energy source that made fossil fuels. In a few sunny places where electric rates are high, like Italy and Hawaii, solar energy is already on the verge of being competitive. But in most places the sun remains by far the most expensive source of electric power—typically in the U.S. it costs several times more than natural gas or coal—which is why it still supplies only a fraction of a percent of our needs.

That won't change fast unless governments give solar a big boost. President Barack Obama campaigned with a pledge to institute a federal "renewable portfolio standard" requiring utilities to generate a quarter of their electricity from renewables by 2025. Yet even if Congress enacted that ambitious law, coal would still dominate the nation's electricity portfolio two decades from now, and solar energy would probably remain a minor contributor (chart). Cap-and-trade legislation that sets a price on carbon emissions would not be a magic bullet for solar either. Both mandates would likely lead utilities to favor the cheapest renewables, like wind. Solar would make a sizable contribution only after 2025, once the expansion of wind energy had plateaued.

Some advocates say we need to encourage solar more directly. European nations have done so with "feed-in tariffs," laws that require electric utilities to pay premiums to solar-power producers, be they commercial power plants or private homes that pump energy to the grid. Such tariffs have made Germany and Spain solar leaders, creating a market that has helped drive down prices. The billions of dollars of tax credits and loan guarantees in the Obama stimulus package may have a similar effect.

Another option is for the federal government to invest directly in solar—for example, says Ken Zweibel of George Washington University, by funding the construction of giant solar plants in the desert Southwest, along with the high-efficiency transmission lines needed to carry the power nationwide. In Zweibel's version of the future, the sun would satisfy more than two-thirds of U.S. electricity needs by 2050, for an investment of about $400 billion. "Compared to what we just paid for the financial bailout, it's pocket change," he says. —*Chris Carroll*



RENEWABLE FUTURES

Under current policies, solar energy is projected to supply just over one percent of U.S. electricity by 2030 (middle bar). If demand for electricity rises, so will fossil fuel use—and carbon emissions. Requiring utilities to generate 25 percent of their power from renewable sources (right bar) would limit the growth of fossil fuels while pushing solar to 4 percent and wind to more than 10 percent of the total. Such forecasts are highly uncertain; policies and markets can both evolve in unforeseen ways.

*PROJECTIONS BASED ON 2005 DATA

**INCLUDES NONBIOGENIC MUNICIPAL WASTE, REFINERY GAS, AND OTHER SOURCES

NOTE: NUMBERS MAY NOT ADD UP TO TOTAL BECAUSE OF ROUNDING.

CHART BY 5W INFOGRAPHICS
SOURCE: UNION OF CONCERNED SCIENTISTS

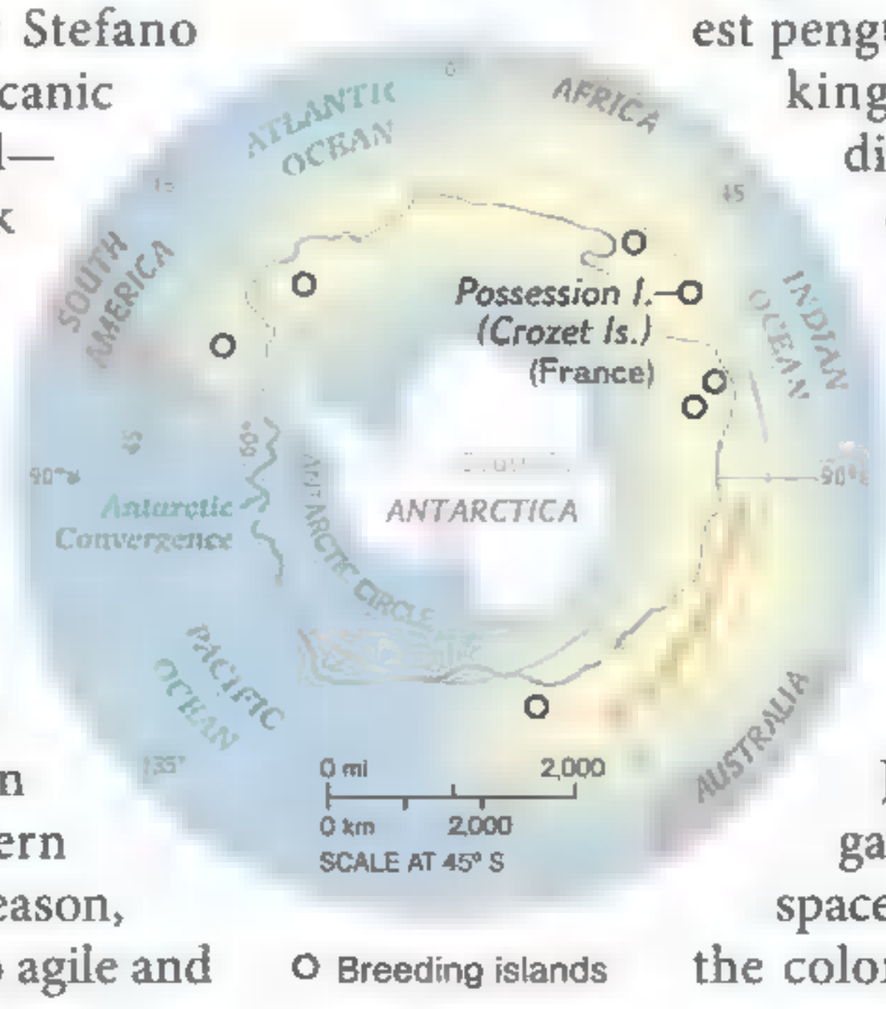
EVERY BIRD A KING

A feeding party streams back to shore after several days at sea. Their orange markings, long, slender bills, and hefty, three-foot-long bodies distinguish them as king penguins. With bellies full of small fish, they will regurgitate a portion for waiting chicks.

PHOTOGRAPHS BY STEFANO UNTERTHINER

FIRST COMES THE NOISE, the turbulent din of king penguins calling, fighting, courting, like the ultimate schoolyard uproar. Then the smell hits, a choking reek of fish and ammonia from the birds' guano. But the assault on ear and nose is only a teaser for what awaits the eye. When photographer Stefano Unterthiner climbed a volcanic ridge on Possession Island—a wet, wind-blasted speck in the Crozet archipelago some 1,400 miles north of Antarctica—he found himself staring into a valley filled wall-to-wall with king penguins, tens of thousands of them, all standing as if gathered for a mass rally. The occasion was summer in the Southern Hemisphere—egg-laying season, the time when penguins, so agile and quick in the water, clumsily come ashore to molt, find a partner, and with luck produce a new crop of chicks. Befitting their name, king penguins cut an impressive figure in the seabird court. As tall as three feet and weighing an average of 30 pounds, they are the second largest penguin, after the emperor. The king is also among the most distinctive, with vivid orange detailing on its head, beak, neck, and upper breast.

On Possession Island king penguins have established six breeding colonies, the largest one on 90 acres of boulder-strewn ground that French researchers have dubbed Jardin Japonais, or "Japanese garden." Far from a meditative space, as Unterthiner discovered, the colony seethes with the drama



CAITLIN SARGENT; NGM MAPS

SOURCES: ERIC J. WOEHLER, SCHOOL OF ZOOLOGY, UNIVERSITY OF TASMANIA; AUSTRALIAN ANTARCTIC DATA CENTRE

Going beak to beak, an adult king penguin challenges ■ skua attempting to make off with a freshly killed chick. Once they reach a few months of age, chicks lose the vigilant daily care of parents and must bunch together for safety and warmth (left). Chick mortality runs as high as 75 percent, many dying of starvation in winter.

of birds defending plots little larger than a manhole cover. King penguins do not build nests. In their constricted space, the male and female take turns incubating a single egg balanced on their feet and covered by a loose fold of skin. They brood the newborn chick in the same way until it grows plumage thick enough to withstand the elements.

During this three-month period, the adults peck at all trespassers. The main offenders are petrels and skuas, avian predators partial to eggs and chicks. Researchers figure that a king penguin parent devotes four hours and 2,000 pecks a day to fighting off interlopers.

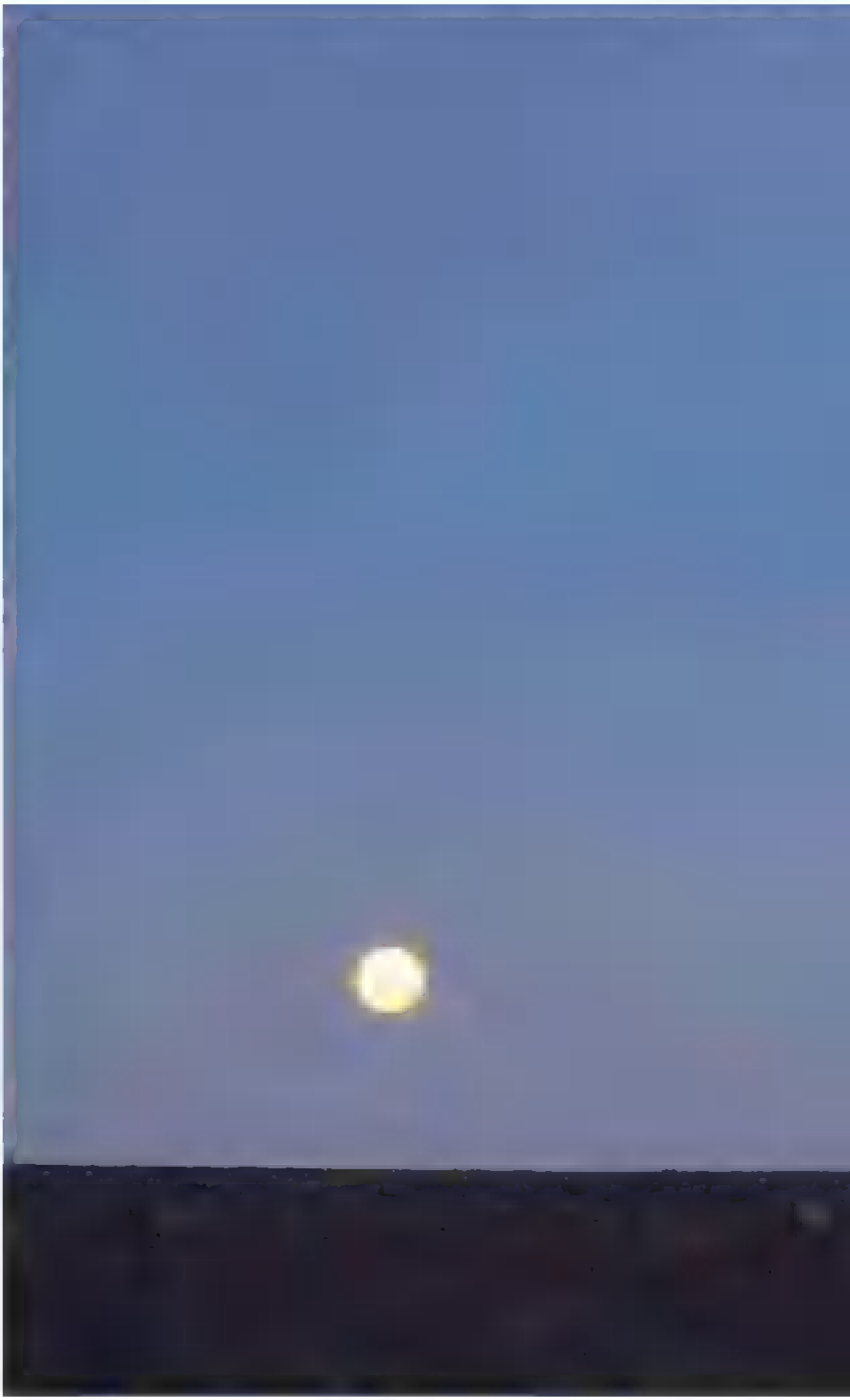
"For all the crowding, there was no sense of chaos," says Unterthiner, who stayed on the island from December to April. "The penguins looked very organized, almost like they were in military formation, each guarding its ground."

King penguins have established colonies across seven islands and island groups in the southern reaches of the Indian and Atlantic Oceans. The islands are crucially located near the Antarctic Convergence, an oceanic boundary where cold polar water meets and mixes with warmer subantarctic seas, producing a rich feeding zone. Prodigious divers and swimmers, king penguins travel 250 miles or more to feed in the depths on squid and bioluminescent lanternfish.

Numbering an estimated 2.2 million pairs, the king penguin population is in good shape. Yet a recent study in the Crozet Islands, where half of all king penguins breed, reveals that warming seas are reducing food resources near the colonies and warns that climate change may pose a serious threat to the species' long-term survival. But for now, the clamor, the stink, and the pecking all bear witness to king penguins still in their full glory. —*Tom O'Neill*

Tom O'Neill is a senior writer for the magazine. Wildlife photographer Stefano Unterthiner is based in Italy. His latest book is The King's Odyssey.

Like figures in a dream, king penguins swoop through sunlit shallows wreathed in kelp. "Penguins can seem like fish," says photographer Unterthiner, "but here they truly are birds flying in water."



As sure as moonrise over Possession Island, king penguins gather each year for “ecstatic display.” Puffing their chests, lifting their heads, and belting out calls, birds of both sexes advertise themselves. Before long, pairs form and join a crowd, and breeding season is on.

Ruins overlook streets where fighting [illegible] capital apart in the early 1990s, leaving the city, and the nation, in chaos

MOGADISHU IS GROUND ZERO FOR THE FAILED STATE OF SOMALIA, A PLACE WHERE PIRATES AND TERRORISTS RULE. YET TO THE NORTH, THE BREAKAWAY REGION OF SOMALILAND IS STABLE AND AT PEACE. WHAT HAPPENED?

SHATTERED SOMALIA

BY ROBERT DRAPER
PHOTOGRAPHS BY PASCAL MAITRE

WAR WITHOUT END
MOGADISHU

Concealed in the courtyard of his home, a street vendor who has joined the Islamist militia called al Shabaab shows off his gun. The group has fought the newly formed transitional government with assassin's bullets, grenade attacks, and roadside bombs—and now controls most of southern Somalia.

A speeding pickup filled with Transitional Federal Government (TFG) forces narrowly misses women cleaning a capital street. With turmoil all around them, residents barely remember what life under a stable government is like


PUL
240

EVERY AFTERNOON MOHAMMED GOES TO THE LIGHTHOUSE.

It is not an obvious refuge. Built nearly a century ago, the Italian lighthouse has been in disuse for years. Its spiral staircase is in a state of mid-collapse. Its hollowed-out rooms smell of sea rot and urine. Young men sit cross-legged in the rubble, chewing qat—a plant whose leaves contain a stimulant—and playing a dice game called *ladu* for hours. Some huddle in a corner and smoke hashish. They seem like ghosts in a city left for dead. But the lighthouse is quiet and it is safe—if anyplace in Mogadishu can be considered safe.

Mohammed, 18, comes for the view. From the top floor he sees the ruins of his neighborhood in the once illustrious Hamarweyne district. He can see the remains of the former American Embassy, the posh al Uruba Hotel, the Shangaani district, once teeming with gold merchants and perfume emporiums—all now blasted away. A lone goat stands in the middle of the main road, while the centuries-old houses alongside it slowly crumble, occasionally burying alive the squatters who inhabit them. Mohammed can also see, just below the lighthouse, the small crescent of sand where he and a few other guys sometimes improvise a game of soccer and the naked children clinging to chunks of discarded Styrofoam as they bob on the waves. He can take in this daily paradox of joy and destruction if he wishes. But he prefers to gaze farther out, at the unspooling carpet of tranquillity that is the Indian Ocean. "I spend my time looking at the sea," he says, "because I know that my food comes from there."

Mohammed is a fisherman. Every morning at five he pushes out into the water with his nets in a small boat. Whatever Mohammed catches, he hauls by wheelbarrow to the market. On mornings when the wind is not too hazardous, his catch fetches two or even three dollars—which means that he, his parents, and his two younger siblings will have enough to eat that day. A mortar blast incapacitated his father years ago, and his family has depended on Mohammed's income since he was 14. He cannot afford the ten-dollar monthly cost to attend school. And anyway, all his former schoolmates have disappeared. Most have joined the Islamic extremist militia called al Shabaab, which in Somalia's latest chapter of misery is locked in a ferocious power struggle with the Transitional Federal Government (TFG), a shaky alliance backed by the United Nations. For young males like Mohammed, al Shabaab is a tempting exit strategy from powerlessness. Then again, many of his former playmates are now dead.

Mohammed has grown up in a country that has collapsed. He had just been born when Somalia's last president, a cultish dictator named Mohamed Siad Barre, was overthrown and the country descended into decades of sustained anarchy. He is one of an entire generation without the slightest clue of what a stable republic looks like. They are learned in other things, however. "M16s, mortars, grenades, bazookas—I can tell each one apart as soon as I hear it," he says.

Somalia's northern coastline, overlooking the approaches to and from the Gulf of Aden into the Indian Ocean, is a base for pirates preying on sea traffic between Europe and the East. When I visited the country last year, Somali pirates were attacking scores of ships off its coast. Yet I found the country's interior to be, if possible, even more volatile. Since then, fierce clashes between insurgents and government troops have accelerated even further as Ethiopian forces, which had invaded Somalia late in 2006 to oust a short-lived Islamic government and prop up the TFG, pulled out in January 2009. The chaos has invited a fresh flow of

In the quiet of an abandoned lighthouse, young people chew qat. The mild stimulant makes the hardships of life in Mogadishu feel more bearable. Ten airplanes loaded with qat arrive at a nearby airport every day.

foreign fighters to Somalia, which has become a haven for terrorists who see themselves engaged in a global jihad. The Fund for Peace has ranked Somalia number one on its index of failed states for the past two years. (See "Why Things Fall Apart," page 98.) That distinction understates the pathos of Somalia. Failure—to deliver security, sustenance, services, or hope—has, for 18 years now, been the house that Somalis call home.

And they are leaving their home in droves. The lucky ones migrate outside the conflict zone—on harrowing journeys to refugee camps in Kenya or Yemen, or to Somaliland, the breakaway republic that once formed Somalia's northern swath. Those less fortunate—more than a million of them—have ended up in camps for internally displaced persons. But many choose to remain in Mogadishu, a city that looks, at first glance, like most of its kind in Africa. A crazed tangle of battered automobiles, mule-drawn carts, and untended goats rules the pocked streets. The markets teem with brilliant mangoes and bananas and junk merchandise from the West. Women in Muslim head scarves pass by, as do boys kicking soccer balls and men with cheekfuls of qat.

Yet amid the exoskeletons of banks and cathedrals and luxury hotels overlooking a glimmering coastline that once buzzed with pleasure boats, an awful truth dawns. Mogadishu was never like other African cities. Mogadishu was a spectacular city. Even in its disfigurement, the beauty is still there—above all, in ghostly Hamarweyne, where photographer Pascal Maitre and I stand in the empty boulevard and squint out at the sea until a call to prayer from a nearby mosque reminds us it is almost five in the afternoon, after which all outside activity ceases. Anyone on the streets of Mogadishu by evening is inviting misadventure.

Just before leaving, we go to the lighthouse, where we meet Mohammed. He sees us, two

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Robert Draper is a contributing writer for National Geographic. *Paris-based Pascal Maitre has photographed in Africa for the past 30 years.*

gaalo, or infidels, and our guards, and at first we hear his footsteps as he retreats somewhere into the shadows. Later he emerges and grows talkative. "We don't want to flee our own country," he tells me. "I don't want to be a refugee. We're ready to die here."

THIS LAND IS BRED FOR TROUBLE. Its nearly 250,000 square miles are, for the most part, deadly dry. Somalia's inhabitants have engaged in a constant competition for its scarce resources —water and pasturage—since antiquity. According to the great Somali ethnographer, I. M. Lewis, Somalia's occupants "form one of the largest single ethnic blocks in Africa." By tradition they are herders of goats and camels and cattle who share the same Islamic faith and the Somali language, and until the colonial era in the late 19th century they continuously occupied much of the Horn of Africa—including what is today Djibouti, northeastern Kenya, and the eastern portion of Ethiopia. In the Somali psyche, fierce nationalism coexists with equally fierce pastoral individualism. It is not their way to look to government for solutions.

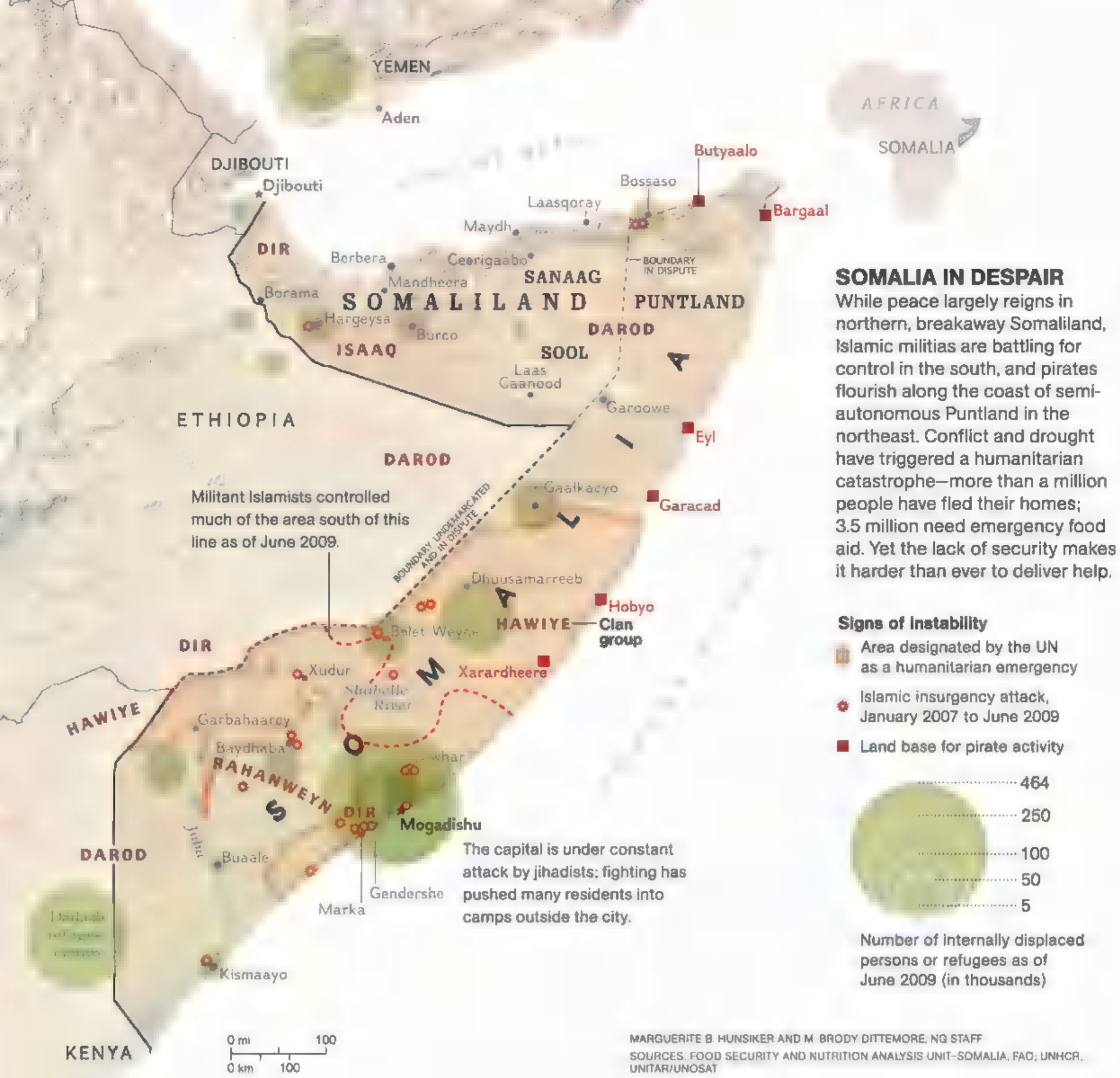
What held Somalia together—and sometimes drove it apart—was its elaborate clan system. The five principal clan families, Darod, Dir, Isaaq (sometimes considered a Dir subclan), Hawiye, and Rahanweyn, have long dominated particular expanses of territory. Within these clans are various subclans and sub-subclans—some cohabiting peacefully and even intermarrying, others sporadically hostile. "You've always had a conflict-prone nomadic society in Somalia, going back to precolonial times," says Andre LeSage of the National Defense University in Washington, D.C. "There was tribal raiding of livestock, but it happened between organized young groups under the authority of a clan elder. They'd say, 'Now is the time this can be done,' and some were killed in pitched battles. But women's and children's lives were generally spared, and villages weren't razed. We shouldn't overly idealize that period. Female genital mutilation was prevalent, and obviously society lacked the benefits of modern health care. But it wasn't anarchy at all. It was highly regulated."

The clan-based checks and balances began to crumble with the arrival of the Europeans. The British in Somaliland ruled with a lighter hand than did the Italians in the south. Though Mogadishu, under Italian rule, became a city of cosmopolitan amenities, the Italians politicized Somali clan hierarchy by rewarding loyal elders, punishing the less loyal, and controlling commerce. Local mechanisms for conflict resolution were badly damaged.

In 1960 the colonial powers departed, and a dreamy nationalism seized the Somali people. With visions of a unified country, Somaliland and Somalia confederated. But nationalism was soon thwarted by clan divisions that had been aggravated during colonial rule. The knotty hostilities left a power void. Into it stepped the dictator General Mohamed Siad Barre in 1969. Barre (a member of the Darod clan) ruled with clever brutality, and many Somalis today speak nostalgically of the stability of his reign. Publicly he outlawed clans, promoting socialism over tribalism and stripping elders of judicial authority. But behind the scenes he practiced a divide-and-rule politics that only worsened clan tensions. Meanwhile, Barre alternately courted the U.S.S.R. and the U.S., with huge stockpiles of weapons as Somalia's principal harvest. An imprudent war with Ethiopia weakened his position. In 1991 militias of the Hawiye clan chased Barre out of Mogadishu. The Somali people, weary of occupiers and strongmen, awaited the next iteration of government.

Eighteen years later, they are still waiting.

MOHAMMED WAS AN INFANT when the civil war between rival militias swallowed up the Hamarweyne district in 1991. "Four months of fighting, right here in our neighborhood," he remembers his parents telling him. "We couldn't get any food. Everyone was so scared." One day a mortar obliterated his neighbors' house and killed the people inside. Some of the shrapnel flew into the home of Mohammed's family, penetrating the neck and rib cage of his father, a policeman under Barre. The family hitched a ride with



SOMALIA IN DESPAIR

While peace largely reigns in northern, breakaway Somaliland, Islamic militias are battling for control in the south, and pirates flourish along the coast of semi-autonomous Puntland in the northeast. Conflict and drought have triggered a humanitarian catastrophe—more than a million people have fled their homes; 3.5 million need emergency food aid. Yet the lack of security makes it harder than ever to deliver help.

Signs of Instability

- Area designated by the UN as a humanitarian emergency
- Islamic insurgency attack, January 2007 to June 2009
- Land base for pirate activity

Number of internally displaced persons or refugees as of June 2009 (in thousands)

MARGUERITE B. HUNSIKER AND M. BRODY DITTEMORE, NG STAFF

SOURCES: FOOD SECURITY AND NUTRITION ANALYSIS UNIT–SOMALIA, FAO; UNHCR, UNITAR/UNOSAT

neighbors northward to Hargeysa in Somaliland, where they stayed for three months. They returned to Mogadishu to find Hamarweyne gutted and gaping holes in their roof.

"We had to start from scratch," Mohammed remembers. The mortar wounds had left his father disoriented and unable to hold a job. Mohammed took to the streets to polish the shoes of strangers, but his mother insisted he quit working and start attending school. Relying on money from an aunt who lived in Saudi Arabia, they got by. During the rainy season, water poured through the roof and flooded their house.

A few years ago, Mohammed's best friend was killed by a mortar while walking along the street. Mohammed couldn't sit in the classroom without thinking of the boy. He quit and became the fisherman he is today, sometimes hauling his daily catch to the sprawling Bakaara market, though the neighborhood there is in the hands of al Shabaab militia. He remembers showing up at the market one day and finding ten people lying motionless in the street. He remembers trying to sleep that night and instead seeing the faces of the dead.

Asked to recall memories of when life was good, Mohammed stares out toward the sea. His smile is not of the youthful kind. "I don't remember any," he says.

TWO WEEKS before my arrival, Mohammed's father woke up in the morning with his usual headache, a lingering result of his injury. He had volunteered to join a group, mostly women, to clean up the rubbish along Maka al Mukarama

WHAT HELD SOMALIA TOGETHER—AND DROVE IT APART—WAS ITS ELABORATE CLAN SYSTEM.

Road—the main thoroughfare from the Mogadishu airport—in exchange for food. He arrived an hour late, just in time to hear the explosion. Lying along the road were his co-volunteers—cut to pieces by a roadside bomb, their faces seared beyond recognition. A child stood, glassy-eyed, over the bodies. Forty-four women were taken to the hospital. Half of them were dead.

The violence has a psychic hold on the city, yet is strangely elusive to visitors. The damage is near but not so near until, in a fearsome rush, it claims you. And thus, it is possible to wake up at six in the morning to concussive blasts, as I do on my fourth morning in Mogadishu—to walk downstairs and out into the shaded patio of our fortified hotel and discover the innkeeper rocking serenely in his swing as he sips his Yemeni coffee, the beans for which he keeps hidden in his bedroom. As I take my seat, he asks if I enjoyed the kingfish we were served the night before. We talk about his children who have emigrated to North Carolina and Georgia. About the power and intelligence of Siad Barre. ("There isn't another, and there won't be another!") About Barack Obama, the excellent pasta he remembers eating in the Italian city of Bergamo, his side business in Dubai—and yes, a bit about the early morning blasts, which turn out to have been mortars launched by insurgents at TFG troops (and which instead killed several innocent civilians), followed by a prolonged exchange of gunfire in the city center. The violence comes up in conversation only glancingly, as a detached happenstance, thoroughly surreal.

Except it's all too real. Later that morning, we visit Medina Hospital, as we have every day since our arrival, in a macabre ritual. Two days ago we visited the women recovering from the roadside bomb on Maka al Mukarama Road—badly burned, several missing limbs, and many visibly pregnant. The new explosion near our hotel has added another 18 victims and sent the hospital into critical mass. The floors and walls are streaked with blood. Disfigured patients lie on stretchers in the hallways and on the porch. Clusters of family members stand nearby—all of them worried, surely, but no one sheds a tear.

While bullets fly and bodies fall, government officials assure us, without the slightest abashment, that everything is under control. "Yes, the tide is turning. The people hate al Shabaab because of what they've done," says Abdifitah Ibrahim Shaaweey, deputy governor for security affairs of the region around Mogadishu, a baby-faced fellow who tours the city with a massive convoy and whose predecessor, his father, was killed in the conflict two years ago. "Of course there are many places where the government has opposition," the commander of Somalia's national army, Yusuf Dhumal, puts it tactfully. He then adds, "But in many parts of the country, there's support for the government," citing several regions of the country—including the semiautonomous northeastern region of Puntland, where pirates flourish. Yet control is slipping away. We drive that afternoon through one of the "controlled" districts to find that its main road has just been blocked off, after a policeman was shot dead there.

SOMALIA'S ONGOING MALAISE can be bewildering to outsiders. "We go into these war-torn countries trying not to be pessimists," says Ken Menkhaus, a Horn of Africa specialist at Davidson College in North Carolina. "But in Somalia we have to recognize that the cynics—those who dismiss peace initiatives as doomed to fail—have turned out to be right for almost 20 years."

Skepticism about Somalia's prospects was tempered briefly in early 2009 when the Ethiopian withdrawal offered hope that the insurgency would fade. A power-sharing accord produced a new version of the TFG, now a broad-based government led by moderate Islamists, which has strong international support. But the new government has struggled to maintain control, as both al Shabaab and

Brimming with charcoal from southern Somalia's dwindling forests, a truck rolls toward a port in Mogadishu. From there the charcoal will be shipped to Persian Gulf countries like Saudi Arabia, which enforce laws protecting their own trees.


USA

LIFE IN A LAWLESS LAND A man pierced by shrapnel from a mortar strike near a mosque joins the scores of wounded who arrive almost daily at Medina Hospital (top right). Since early 2007 Mogadishu has lost more than half its population, as civilians flee fighting between the government and insurgents. Many of the roughly 750,000 people who remain are the poorest of the poor, like the mother and baby sheltering under ■ bullet-ridden truck at a feeding center (bottom right). Jobless, often homeless, faced with soaring food prices, they survive on humanitarian relief. On the shore children still play, and fishermen drop anchor nearby, but the hulks of derelict hotels (below) stand vacant.

Clutching bowls, boys wait at a feeding center for what could be their only meal of the day—a soup of corn and lentils. Once aid groups handed out dry rations. Now they distribute food cooked, to avoid attracting looters.

IN A PLACE GONE TO HELL, AL SHABAAB IS THE BEST EMPLOYER IN TOWN.

another hard-line Islamist insurgency, Hizbul Islam, have taken over much of central and southern Somalia. By June forces loyal to the fragile government held only seven of Mogadishu's 18 districts. The latest fighting has killed more than 200 people and displaced tens of thousands more.

Why is the violence so intractable? A clarifying paradigm can be found immediately to the north, in Somaliland. No visual distinction marks the Somalilander from the Somali. But the naked eye detects plenty of differences between the two regions. Somaliland's capital city of Hargeysa is an almighty wreck of sledgehammered streets, ungoverned traffic, litter, and refugee camps, but there are two things there that you will not find in Mogadishu. The first is a construction boom—of hotels, restaurants, business centers. The second are the currency-exchange booths everywhere on the streets, where women sit alongside yard-high stacks of Somaliland shillings, unaccompanied by security of any sort.

What one almost never sees in Hargeysa is violence. The last time the weapons of Somaliland came out was in 1996, a few years after the fabled peace conference in the town of Borama. Barre had been deposed, and opposing warlords engaged in a civil war to the south, threatening the stability of the north. At Borama a group of elders came together to reconcile clan conflicts at what one participant calls "the Guinness record kind of conference—months of talking and finally agreeing on a charter to set up a government. And while we were having this conference, out in the countryside, everyone came and put their guns under a tree."

Because the fledgling democracy has relegated much authority to elders and sheikhs, peace has largely endured. (A startling exception occurred last October when a string of suicide bombs—apparently arranged by al Shabaab—went off in Hargeysa, leaving dozens dead.) Somaliland has benefited from greater clan homogeneity and a port at Berbera that does not suffer the piracy afflicting the Somali coast.

True prosperity, however, has not followed; Somaliland is hardly on track to be the next Dubai. The commercial thoroughfare connecting neighboring Ethiopia to Hargeysa and to the port at Berbera is largely untrafficked, with roadside goats and camels more in abundance than cars. The Somaliland city of Burco is a bustling aggregate of low-slung market stalls, its ethos deeply in the sway of Islam. The highway linking Hargeysa and Burco to the vast Sanaag region's administrative capital of Ceerigaabo simply disappears a couple hundred miles shy of its destination—requiring an eight-hour trek the rest of the way through roadless desert, with only the occasional oasis shanty or camel herdsman to rely on for navigation. And the once impressive canopy of acacia trees beyond the northern peaks of the Sanaag region has been badly plundered (as have forests throughout Somalia). The lumber is burned to charcoal, bagged in burlap sacks, and then barged out to Persian Gulf countries. "They're just poor people making money to feed their families," acknowledges Ceerigaabo's mayor. "But it's a bad mistake. I wish the international organizations could help by bringing in some other means of livelihood."

This sentiment is universally expressed throughout Somaliland, which no government has recognized as a sovereign nation. In Somalia it may feel as if the world has abandoned the country, but from Somaliland's perspective, its southern neighbor has stolen the world's attention. "This is the question I ask when I go to Europe and the U.S.," says Somaliland's president, Daahir Rayaale Kaahin. "Why does Somaliland, with all its success, not receive support from the international community, while Somalia receives all this aid and yet never makes any success? Nobody answers me." President Rayaale's request has begun to receive sympathy from some outside nations, but generally the wish seems to be that Somaliland stand united with—and thereby help rescue—Somalia.

President Rayaale believes this is a misguided approach. "Leave aside this dream of a Greater Somalia," he says. "Let us just be a good neighbor, a functioning state near them. Let

them sit like we have sat, under the trees."

But if we ask the Somalis to sit under the trees, will they leave their weapons there?

THE TERRORIST SELLS SOFT DRINKS and ice from his market stall in southern Mogadishu. He is 22, tall, and bony, with beautiful eyes and a sweet smile. He offered a furtive wave as we drove past. We met the next day, after he had spent the evening with his lieutenants, praying together and fashioning explosives.

The young man is an emir for al Shabaab—originally the youth militia for the Islamic Courts Union (ICU), an alliance of sharia courts that united to take control of southern Somalia during the summer and fall of 2006. The ICU's creeping radicalization and expressed desire for a Somali caliphate was what prompted Ethiopia (with U.S. backing) to invade Somalia, defeat the ICU, and bring the TFG to power later that year. The ICU's brief reign was largely peaceful, but its offspring—the al Shabaab militia—has shown a far greater appetite for violence and reportedly has links to al Qaeda.

At one time, this young emir had 120 mujahideen under his control. "Now I have about 60 or 70," he said when we spoke last year. "The others have left the country. Or they're in paradise." In a quiet, almost ephemeral voice, he explained that al Shabaab's aim was "to reclaim the country and establish an Islamic state. Until our last daughter is no longer alive, we'll continue fighting. We don't want democracy. If they leave us to our dignity, we can rule Somalia."

He discussed his rigorous training and how a top al Shabaab leader, Aden Hashi Ayro—later killed by an American air strike for his ties to al Qaeda—personally taught him how to construct land mines. When I asked him where al Shabaab was getting its supply of munitions, he said that much had been purchased across the border, from Kenya. But, he added, "we've received some support in the past from Eritrea, with their big guns and ammunition, and now they're ready to support us further. But there's no way to get the weapons to us overland." The solution, he explained, was for them to capture the southern coastal town of Kismaayo, an area of heavy conflict between the government and the extremists. "If we get it," he said, "then we'll have our own port. And we can receive what we need from there."

Less than an hour after he left, our fixer received a call. Kismaayo had just fallen to al Shabaab. The extremists would soon have their fill of weapons.

WE WILL PAY YOU $150. Members of al Shabaab approached Mohammed and offered the young fisherman an advance payment in American cash if he would join their organization. Every month, they told him, you will be paid that same amount for your services. Mohammed did not say yes. But he also did not say no.

Mohammed brought up the matter with his family. For years they had been subsisting on fish and corn. A salary like that could make a big difference. In a place gone to hell, al Shabaab is the best employer in town and offers direction amid daily uncertainty. For weeks the family debated the pros and cons. Mohammed himself was in anguish. Most of his friends who had joined al Shabaab had been deported, arrested, or killed. And this fact, more than any moral epiphany, is what ultimately carried the day. As Mohammed's father would tell me, "When you join, you cannot leave. His colleagues who had joined—they never came back to their families. So it's better that he work at the sea and catch fish."

The father's eyes are watery as he recounts this. "Mohammed is taking care of us," he says quietly. "It affects me psychologically that our child must have this responsibility."

FOOD IS POWER IN SOMALIA. Militia groups have routinely descended on the arable lands of central Somalia during harvest and claimed the crops for themselves. Pirates on the Indian Ocean have waylaid dozens of foreign vessels bearing food aid. Food prices were high here even before last year's worldwide spike, thanks to drought, militia roadblocks, and a devalued currency. The result is that millions now depend on food aid. The fresh fighting is pushing the country

THE LOCALS STARE AT THE FOREIGNERS. WORD OF THE KIDNAPPINGS HAS SPREAD.

toward an unprecedented humanitarian crisis.

The violence displaces people from their homes, which causes an upsurge in crowds at the feeding centers in Mogadishu. Lines form before the gates open at noon. The hungry stand with their bowls, chatting with each other, dignified as Somalis always seem to be. Behind the gates, workers funded by Western and UN donors stir large vats of millet and vegetables. None of them are foreigners, but because they are funded by Western agencies, they do not wear their official tunics around town for fear of being kidnapped or killed.

As the gates slide open, a woman files in, sees me, and whispers something to an aid worker: "Tell him we're praying for the gaalo because they're feeding us. The jihadists don't feed us anymore. They're killing us."

THE KILLING IS ALL AROUND US. But the danger does not come our way until our eighth day in Somalia. We drive out Saturday morning in two SUVs filled with armed guards, bound south for the Italianate coastal town of Marka. The 60-mile stretch of road between the two cities is almost entirely in the control of al Shabaab. (In the following months, al Shabaab will win control of Marka and most cities in south-central Somalia.) Because of this, the one-day trip is the fruit of lengthy negotiations between our fixer and the insurgents. It is understood that once we leave Mogadishu's city limits, our TFG-sanctioned guards will depart our vehicle and be replaced by militia guards. Such precautions cost money, which we are fortunate to have. Two journalists in a car a few miles behind us are not so lucky.

They are youthful freelancers—one from Australia, the other from Canada—and they have just arrived, possessing determination but little experience or money. They have convinced a fixer to take them to an internally displaced persons (IDPs) camp about ten miles outside of Mogadishu, along the same road we are traveling. They have paid for TFG guards, but not for militia security to ferry them the final few miles to the refugee camp. Their gamble proves to be a fateful one.

The highway teems with wandering refugees and with convoys bearing heaps of charcoal from the forests to the south. Thirty minutes into our trip, our fixer says to us, "I've been calling the others. They're not picking up." He phones the journalists' TFG security. Yes, their car made it to the city-limits checkpoint. He phones the IDP camp. They have not arrived. By the time we arrive in Marka, a member of al Shabaab calls with the news. The two freelance journalists have been kidnapped. The ransom will likely be a million dollars each. The presence of the other two gaalo along the same stretch of highway has been duly noted. All bets are off for us.

We spend the evening at a guesthouse in Marka. It is not safe to drive back to Mogadishu the way we came, and it's the only road to the city. A United Nations plane is due to arrive in two days; we could take it back to Nairobi, though our luggage and passports are at the hotel in Mogadishu. In the end we decide on another course. A powerful man in Marka offers to loan us his militia of a dozen heavily armed, young men affiliated with al Shabaab. They will escort us to the city limits, where our TFG unit will bring us back to the hotel and then to the airport. The cost is $500 in cash. The thoroughfare will be the beach along the Indian Ocean.

We wait the next morning for the tides to roll back the waves. Then, just before eleven, we pull out of the guesthouse and trundle through town—our two SUVs plus a flatbed truck loaded down with a dozen young men with M16s, Kalashnikovs, ammo belts, and an immense rotating machine gun bolted to the bed of the truck—while the locals stare at the foreigners with knowing eyes, as word of the kidnappings has spread. We drive through the markets, past a small mountain of tortoise shells, and then nothing is before us but the beach. The waves thrash against the tires. The militia men chatter excitedly amongst themselves, and whenever the truck gets stuck in the sand—which is every one or two miles—they jump out of our car to push. I can't help but think: There is little to

Near the ruins of Somalia's old parliament, an unemployed traffic officer directs traffic for tips from drivers grateful for a sign of normalcy. "He thirsts for stability," says Somali journalist Harun Hassan. "It's inspiring."

prevent these men from keeping our $500 and taking us hostage as well.

The beach gives out without warning a quarter of the way into our trip. A dirt road appears and leads us into the town of Gendershe, once favored as a resort town. Now it is in the hands of Islamic militants. The road narrows as we enter the handsome stone village, and several men appear. They instruct our escorts to turn off the music in our car. Their eyes widen when they see the two gaalo. But a few of the men in the truck know the Islamic elders, and minutes later we are motioned through to the other end of Gendershe, where a checkpoint rail is lifted and we are allowed to pass through.

The beach soon reappears. A couple of small fishing boats are visible, and a few goat herders, and that is all. At about the halfway point, during one of the militia truck's many mechanical failures, all of the passengers step out of their vehicles, and we all stride toward the ocean and gaze out into the horizon. I break out a box of granola bars. We chew and we stare and we take pictures, and it is at precisely this moment that I realize we will be OK.

Back at the hotel we are hugged by the employees. Mohammed the fisherman and his father come to see me a final time. I hand him $20. He gives $15 to his father and keeps the other $5. "Qat and cigarettes," he says with a smile. "That's my night."

The Mogadishu airport is full of passengers—many of them with heavy bags, indicating that this is their goodbye as well. All of them stare at the gaalo, and I wonder if there is a final surprise in store for us.

There is. One by one, they walk up to us. And shake our hands. And tell us, through our fixer, how sorry they are about the other journalists. How grateful they are that we have come. How sad it is that things are this way. How hopeful they are that we can tell the outside world.

As this story goes to press, despite diplomatic efforts, the two journalists are still being held for ransom. And Somalia's people are still waiting for peace. □

GOING IT ALONE
SOMALILAND

Townsmen in the breakaway Republic of Somaliland shoulder goats to a boat for export. Hundreds of miles separate the former British colony from the turmoil in southern Somalia. With no international recognition and scant outside help, Somaliland's leaders have built a stable, functioning government.

In ■ cocoon of calm, women have their hair styled and feet decorated with henna in Hargeysa, Somaliland's capital. "We are peaceful, not like Somalia," says salon owner Zamzam Mohamed. "We will develop our country."


SALON

OASIS OF ORDER Central-bank staff inspect newly printed Somaliland shillings, an independent currency created in 1994, a few years after Somaliland broke away from chaotic southern Somalia. Somaliland's fledgling government has managed to successfully crack down on pirates with a robust arrest policy. Last year authorities detained a crew led by Farah Ismail Eid (below, at left), now serving ■ 15-year sentence in Mandhera Prison. Rebuilt after dictator Mohamed Siad Barre bombed it flat in the late 1980s, Hargeysa is in the midst of ■ construction boom—with hotels like the City Center (bottom right)—mostly financed by returning expatriates. But experts worry Islamic extremists may be infiltrating Somaliland: In October 2008 suicide bombers struck locations across the capital.

On her own in drought-stricken Sool, along Somaliland's disputed eastern border, a nomadic woman watches over her herd. Largely abandoned by the rest of the world, Somalis struggle to carry on in a lawless land.

WHY THINGS FALL APART

IT CAN HAPPEN AFTER ONE FATEFUL EVENT—a civil war, natural disaster, or brutal takeover—or insinuate itself gradually, like a cancer that eats away at a country for decades. But when a nation is failing, you see it in the eyes of its people.

Over a billion people live in countries in danger of collapse. Some leaders lose control over their territory and cling to their capitals while warlords rule the provinces. Many governments are unable or unwilling to provide the most basic of services. Most are hobbled by corruption and environmental degradation. Such unstable states are dangers not just to themselves but also to the whole world. They incubate terrorism, criminal organizations, and political extremism—because when your country is falling apart around you, any way out can seem like a good way out.

Geography can make a country more vulnerable to instability. Just finding itself in a bad neighborhood puts a country at risk; the war in Iraq, for instance, sent a flood of refugees into neighboring Syria. Crowded nations with huge populations, like Bangladesh, face special challenges. But so do vast countries like Chad, whose very size defeats infrastructure. Landlocked nations with poor soil and little water struggle for self-sufficiency. Yet countries rich in natural resources, such as the Democratic Republic of the Congo, don't always come out ahead. In what is called the resource curse, abundant oil or diamonds can breed competition among elites for control of those lucrative assets.

Historical and cultural tensions can dog nations as well. Nowhere is this more evident than in Africa, home to the top five countries in this year's Failed States Index (right), compiled annually by the Fund for Peace. "The colonial drawing of arbitrary borders across ethnic and even topographic lines created artificial states," says the Fund's president, Pauline H. Baker. Such regimes often devote more energy to consolidating authority than to fostering national identities and robust government institutions.

One African country that has prevailed over its colonial legacy is Senegal. "It's benefited from enlightened leadership," says Baker. Indeed, the most important factor for ensuring a state's stability is good governance, says Davidson College political scientist Ken Menkhaus. Establishing the rule of law, with institutions to support it, "allows for a predictable investment climate and discourages the rise of armed insurgencies."

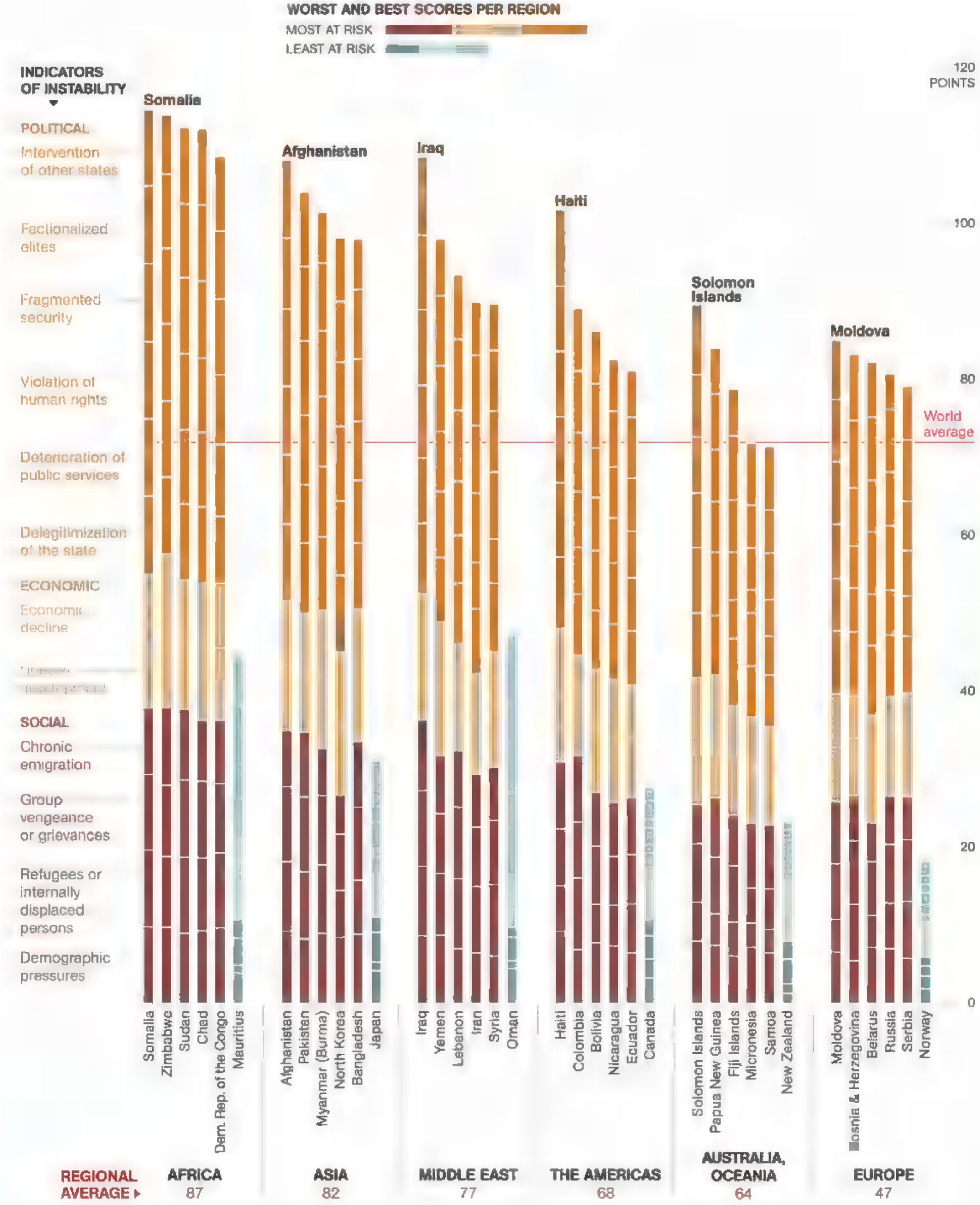
Assistance from organizations like the World Bank and United Nations has a mixed record of staving off failure. The most dramatic success stories are countries like India and South Africa that reformed themselves from within. As the United States' recent experiences in "nation building" illustrate, promoting political stability with outside military intervention is far from easy. Iraq and Afghanistan currently rank as the sixth and seventh most precarious states on the planet.

Then there is Somalia, a country whose geography, history, and clan dynamics give it the grim distinction of topping the index for two years in a row. Beyond Somalia, there's little agreement on what a high score on the index really means for a country's future. Colombia, for example, lacks control over parts of its territory. So, has Colombia failed? The bloody aftermath of Kenya's 2007 elections caused the country to go from 26th to 14th in this year's index. But does this backslide foretell failure for Kenya, with its vibrant entrepreneurial class?

Scholars caution against judgment. University of Hawaii professor Tarcisius Kabutaulaka says it's easy to forget that many countries have had troubled histories. "The United States was built out of chaos, out of civil war. And now we expect the rest of the world to adopt our institutions but do it without violence in a short period of time."

In the end, the question of whether a country is failing may best be answered by its own people. If their eyes say "we have been deserted," the verdict has been rendered. —*Robert Draper*

THE 2009 FAILED STATES INDEX ranks Somalia highest for the second year in a row. Issued since 2005 by the Fund for Peace and *Foreign Policy* magazine, the index weighs 12 political, economic, and social factors to calculate a nation's instability and focus world attention where support is needed.



HIRAM HENRIQUEZ, NG STAFF. SOURCES: FUND FOR PEACE; *FOREIGN POLICY*

Love & Lies

{ORCHIDS}

How do you spread your genes around when you're stuck in one place? Like animals, including us, [illegible] to fa[illegible]


A Masdevallia orchid's rotten aroma irresistible to a fly.
REGACIA (MASDEVALLIA) PRINCEPS;
LIKELY ACALYPTRATAE SP. (FLY)


On the island of Sardinia
the flowers of mirror orchids
perfectly mimic the reflection
of blue eyes on female wasps'
wings. Male wasps beguiled
by the flower's sight and scent
are lured into service carrying
pollen from plant to plant.

Following a perfume trail to its source, male wasps in Australia ravish a king spider orchid. Sure the red "lip" a mate, they rub against one will take away the plant's pollen. Every orchid has a petal modified pollination, some theatrically so

CALADENIA PECTINATA, THYNNID WASP

BY MICHAEL POLLAN
PHOTOGRAPHS BY CHRISTIAN ZIEGLER

WE ANIMALS don't give plants nearly enough credit. When we want to dismiss a fellow human as ineffectual or superfluous, we call him a "potted plant." A "vegetable" is how we refer to a person reduced to utter helplessness, having lost most of the essential tools for getting along in life. Yet plants get along in life just fine, thank you, and did so for millions of years before we came along. True, they lack such abilities as locomotion, the command of tools and fire, the miracles of consciousness and language. To animals like ourselves, these are the tools for living we deem the most "advanced," which is not at all surprising, since they have been the shining destinations of our evolutionary journey thus far. But the next time you're tempted to celebrate human consciousness as the pinnacle of evolution, stop to consider where you got that idea. Human consciousness. Not exactly an objective source.

So let us celebrate some other pinnacles of evolution, the kind that would get a lot more press if natural history were written by plants rather than animals. (I suppose an article by a biped named Pollan will have to do.) For while we were nailing down locomotion, consciousness, and language, the plants were hard at work developing a whole other bag of tricks, taking account of the key existential fact of plant life: rootedness. How do you spread your genes around when you're stuck in place? You get really, really good at things like biochemistry, at engineering, design, and color, and at the art of manipulating the "higher" creatures, up to and including animals like us. I'm thinking specifically of one of the largest, most diverse families of flowering plants: the 25,000 species of orchids that, over the past 80 million years or so, have managed to colonize six continents and virtually every conceivable terrestrial habitat, from the deserts of western Australia to the cloud forests of Central America, from the forest canopy to the underground, from remote Mediterranean mountaintops to living rooms, offices, and restaurants the world over.

The secret of their success? In a word, deception. Though some orchids do offer conventional food rewards to the insects and birds that carry their pollen from plant to plant, roughly a third of orchid species long ago figured out, unconsciously of course, that they can save on the expense of nectar and increase the odds of reproducing by evolving a clever deceit, whether that ruse be visual, aromatic, tactile, or all three at once. Some orchids lure bees with the promise of food by mimicking the appearance of nectar-producing flowers, while others, as in the case of a *Dracula* orchid, attract gnats by producing an array of nasty scents, from fungus and rotten meat to cat urine and baby diaper. (Believe me, I've sniffed them.) Some orchids promise shelter, deploying floral forms that mimic insect burrows or brood rooms. Others mimic male bees in flight, hoping to incite territorial combat that results in pollination.

But perhaps the most clever deceit of all is offered by those orchids that hold out the

LIPARIS SP.

Rabbit-shaped flowers hop to life on a tree in Borneo. The fingernail-size blooms belong to a tropical genus that rings the Equator and may date back some 80 million years.

WHAT I LEARNED OF THE PROSTITUTE ORCHID FORCED ME TO REVISE MY ESTIMATION OF WHAT A CLEVER PLANT IS CAPABLE OF DOING TO A CREDULOUS ANIMAL.

promise of sex. And not exactly normal sex. Really weird sex, in fact.

HOPING TO OBSERVE some of this plant sex, said biped recently journeyed to Sardinia, a windswept, mountainous, and lightly populated island 120 miles off the west coast of Italy that has long been known for floral biodiversity and human kidnapping. (Deceit is evidently very much in the air.) I went in search of one of the most ingenious and diabolical of orchids: the *Ophrys*. (Some botanists call it the "prostitute orchid.") I'd been eager to lay eyes on this orchid and meet its hapless pollinator ever since reading about its reproductive strategy, which involves what my field guide referred to as "sexual deception" and "pseudocopulation." What I learned of the prostitute orchid forced me to radically revise my estimation of what a clever plant is capable of doing to a credulous animal.

In the case of this particular *Ophrys*, that animal is a relative of the bumblebee. The orchid offers no nectar or pollen reward; rather, it seduces male bees with the promise of bee sex and then insures its pollination by frustrating precisely the desire it has excited. The orchid accomplishes its sexual deception by mimicking the appearance, scent, and even the tactile experience of a female bee. The flower, in other words, traffics in something very much like metaphor: This stands for that. Not bad for a vegetable.

Orchid hunting can be arduous in many places, but in the mountains of Sardinia *Ophrys* orchids grow like roadside weeds. When they bloom in April you can spot them from a moving car. Close up, the lower lip, or labellum, of these diminutive orchids bears an uncanny resemblance to a female bee as viewed from behind. This pseudobee, which in some *Ophrys* species comes complete with fake fur and what appear to be elbows and folded iridescent wings, looks as though she has her head buried in a green flower formed by the actual flower's sepals. To reinforce the deception, the orchid gives off a scent that has been shown to closely match the pheromones of the female bee.

When it comes to getting an orchid pollinated, sexual deception has an uneven success rate (more on that later), but when it does work, it works like this: The real male bee alights on the beelike labellum and attempts to mate, or in the words of one botanical reference, begins "performing movements which look like an abnormally vigorous and prolonged attempt at copulation." In the midst of these fruitless exertions, the bee jostles the orchid's column (a structure that houses both the male and female sexual organs), and two yellow sacs packed with pollen (called the pollinia) are stuck to his back with a quick-drying gluelike substance. Frustration mounts, until eventually it dawns on the bee that he has been had. He abruptly flies off, pollinia firmly attached, in frantic search of more authentic female companionship.

There was something poignant about the bee I spotted, flying around madly with what looked like a chubby pair of yellow oxygen tanks strapped to his back. He'd been deluded by the promise of sex—bee sex—when in fact all that was on offer was plant sex, and unbeknownst to the bee, now searching for a second, more satisfactory liaison, he was right in the middle of that act. Botanists have been known to refer to pollen-carrying bees as "flying penises," but of course most of the world's bees perform in that role unwittingly, with food rather than sex on the brain. Not so for the poor, deluded orchid bee.

THE POLLINATION STRATEGY of the *Ophrys* is, like that of so many orchids, ingenious, intricate, wily, and seemingly improbable—so much so that proponents of intelligent design sometimes point to orchids as proof that the hand of a higher intelligence must be at work in nature. (And a rather sadistic intelligence at that.) Yet the peculiarities of orchid sex actually offer one of the great case studies of natural selection, as Charles Darwin himself understood. Darwin

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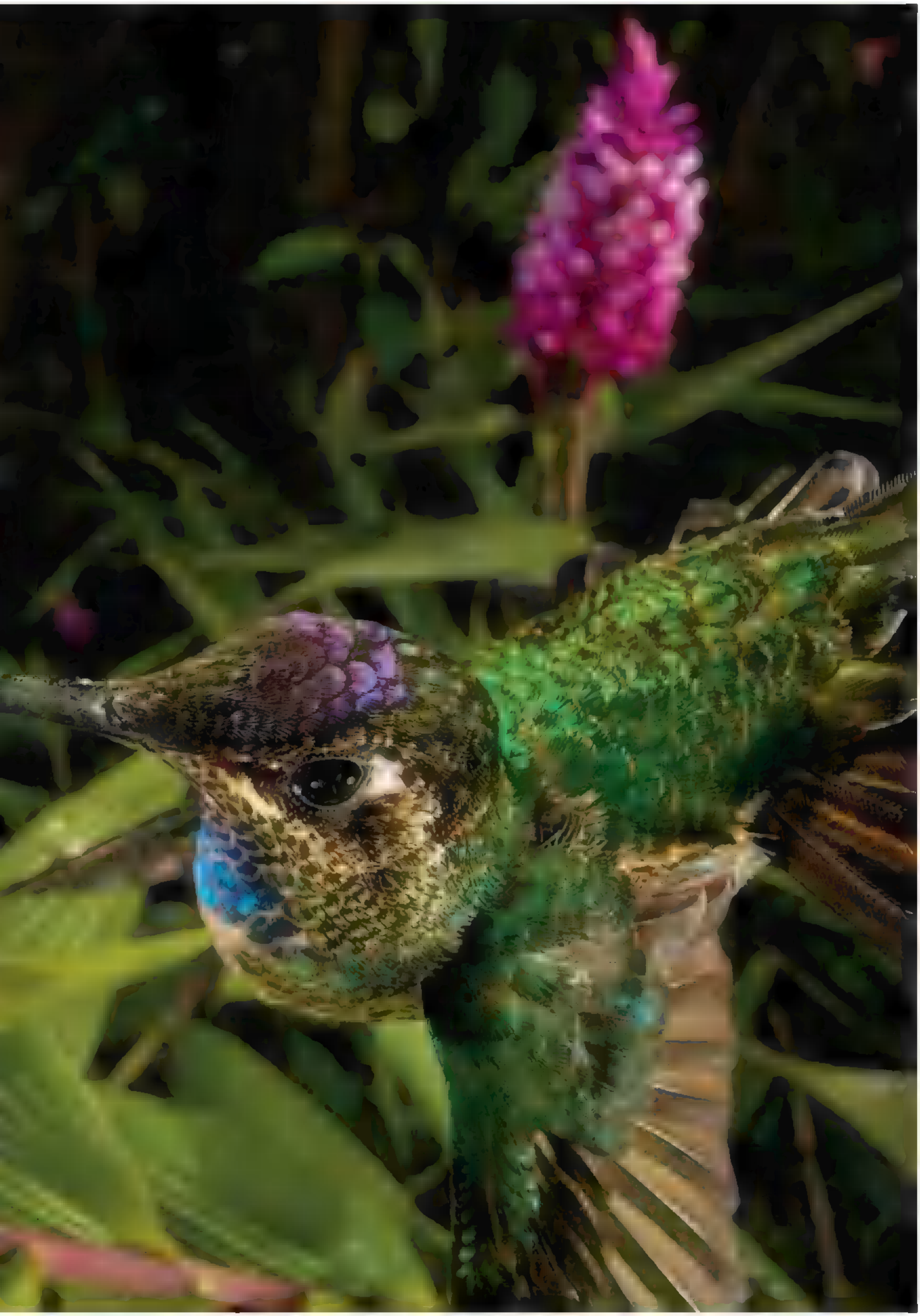
Michael Pollan is the author of In Defense of Food *and* The Botany of Desire, *to be adapted for public television this fall. Christian Ziegler's photographs of plant mimicry appeared in last month's issue.*

Different pollinators warrant different wiles. To affix yellow pollen sacs to a male sand bee, a wild Italian hybrid (above) dresses up like a female bee. To recruit a butterfly for gene distribution, an Epidendrum *in Panama (below) imitates milkweed, a favored food. More ruses come to light among the 500-odd new wild orchid species discovered yearly.*

TOP: *OPHRYS ELEONORAE X O. LUPERCALIS; ANDRENA SP.* (BEE). ABOVE: *EPIDENDRUM RADICANS, HELICONIUS MELPOMENE THELXIOPE* (BUTTERFLY)


hummingbird's bill so
nearly matches the color o
this Panamanian orchid
pollen sac that the bun
often borne away unno
Many plants self-pollir
but most orchids need
to reproduce.
ELLEANTHUS SP., EUGENES FULGENS
(HUMMINGBIRD)



WHY WOULDN'T NATURAL SELECTION WEED OUT INSECTS SO FOOLHARDY AS TO MATE WITH NATURE'S VERSION OF THE INFLATABLE LOVE DOLL?

was fascinated by orchid pollination strategies, and though he was puzzled by the purpose of *Ophrys*'s uncanny resemblance to bees (pseudocopulation wasn't observed until 1916), he taught us much of what we know about these plants in *The Various Contrivances by Which Orchids are Fertilised by Insects*, the volume he published immediately after *The Origin of Species*. Indeed, some scientists believe that had he published his orchid book first, the theory of natural selection might have encountered less skepticism than it did. Why? Because in orchids Darwin identified floral structures "as perfect as the most beautiful adaptations in the animal kingdom." He painstakingly demonstrated how even the most unlikely features of these flowers serve a reproductive function, and many of these structures are so perfectly adapted, both to the plant's requirements and the morphology of its pollinators, that they offered Darwin elegant proofs of his outlandish theory.

In one famous case, putting the final QED on Darwin's proof that evolution had tailored a flower to lure and exploit a specific pollinator had to wait a few decades. Attempting to explain why the star orchid of Madagascar would secrete a drop of nectar at the tail end of a foot-long floral spur, where no known pollinator could possibly get at it, Darwin hypothesized the existence of a moth with a 12-inch-long tongue, an unlikely creature that had never been observed. Vindication arrived a couple decades after Darwin's death, when entomologists unfurled the tongue of a newly discovered hawk moth and found that it measured nearly a foot long.

THE ORCHID'S BAROQUE pollination strategies do raise challenging questions for the evolutionist, however. Since natural selection seldom rewards the unnecessary complication, why haven't all orchids stuck with the more straightforward pollination strategies based on nectar reward? And how in the world did their sexual practices get so elaborate? As for the hoodwinked pollinators, what, if anything, do they gain? If the answer is nothing but frustration, then why wouldn't natural selection eventually weed out insects so foolhardy as to spend their time mating with nature's version of the inflatable love doll?

Botanists and evolutionary biologists have come up with fascinating answers to many of these questions. John Alcock, an evolutionary biologist and author of *An Enthusiasm for Orchids*, proposes two explanations for why some orchids would have evolved to avoid a simple nectar reward. When botanists experimented by adding a nectar reward to a normally nectarless orchid, they found that the pollinators hung around longer, happily visiting other blooms on the same and nearby plants. This does not suit the orchid's interests, however, since inbreeding results in lower quality seeds. By comparison, outcrossing, or mixing one's genes with distant mates, increases vigor and variation in one's offspring, maximizing fitness. The sexual frustration of a deluded bee turns out to be an essential part of the orchid's reproductive strategy. Determined not to make the same mistake again, the bee travels some distance and, if things work out for the orchid, ends up pseudocopulating (and leaving his package of pollen) with an orchid a ways off. That distant orchid is likely to look and smell ever so slightly different from the first, and some botanists believe these subtle variations from plant to plant are part of the orchid's strategy to prevent bees from learning not to fall for a flower. "Imperfect floral mimicry" is the botanical term for this adaptation. Think of it: The very imperfection of the orchid's mimicry may itself be part of the perfection of its reproductive strategy.

Another reason so many orchids have gotten out of the restaurant business may have to do with the benefits of developing a relationship with a single, highly devoted pollinator. Nectar, besides being metabolically expensive for the flower to produce, is beloved by so many different animals that it attracts all sorts of riffraff that may not deliver your pollen to the right target. But if you produce a scent that attracts only the males of one particular species of bee, you can insure that your pollen will end up precisely

CATASETUM VIRIDIFLAVUM

Male flowers of tropical Catasetum *orchids conceal a pollen-loaded slingshot, which fires its sticky bundle when a prospective pollinator jostles the trigger. Bees are prime targets.*

where you want it: on the stigma of a far-flung orchid of your own kind.

The exactitude of the perfume business may also help explain the astounding diversity of the orchid family. A mutation producing even a slight change in an orchid's scent could, strictly by chance, turn out to be the key that unlocks the sexual attentions of a new pollinator, while at the same time completely turning off the original pollinator. In this way, variations in the chemistry of floral scent can function much as geographic isolation does in the creation of new species, by preventing new mutant flowers from being pollinated by older ones. The novel orchid might evolve in genetic isolation from its forebears—a prerequisite for creating a new species.

Orchids have excelled at spinning off new species, and yet there are remarkably few orchid plants in the world. Their relative rarity in the landscape puts a premium on highly customized pollination strategies to deploy their pollen as efficiently as possible—unlike grasses, for instance, which can simply broadcast their pollen on the wind. Yet their small numbers ensure their survival. If deceptive orchids were much more common, their ruses would no longer work, since they depend on the ubiquity of honest flowers. Orchid deception can succeed only in a world where most things in nature really are what they seem: where the smell of rotting meat signals rotting meat, where flowers really do offer nectar and don't dress up as bugs.

It seems fair to say that when it comes to their own sex, orchids have opted for quality rather than quantity. For while sexual deception doesn't fool all of the pollinators all of the time, it does fool some of them some of the time, and for an orchid that is quite enough. That's because each pollinium contains a stupendous number of pollen grains, and once they're delivered, every resulting seedpod contains an

Courting bees and beetles, the nectarless pansy orchid impersonates a nutrition-rich neighbor, the pea flower. It's unique to Australia, an evolutionary hothouse that Perth botanist Kingsley Dixon says "bulges with deception."

DIURIS MAGNIFICA

They look like birthday bow
festooning Panama's brush, but
it's the aroma of bucket orchids
that draws pollinating bees.
Smithsonian horticulturist
Tom Mirenda says that to
them, the flowers' smell is as
luscious as "five kinds of
dessert baking at once."
CORYANTHES PANAMENSIS

TODAY THERE ARE 100,000 HYBRID ORCHIDS, THE OFFSPRING OF MARRIAGES AMONG FAR-FLUNG PLANTS ARRANGED BY, AND INCONCEIVABLE WITHOUT, US.

equally stupendous number of seeds. So while sex among the orchids may be a rare and intricately choreographed affair, what happens after the match is made is all about profligacy and chance. Orchid seeds are so tiny and minimalist they don't even contain a source of food for the developing embryo. For this, the orchid must (once again) count on the kindness of strangers—in this case, that of an endophytic fungus. If all goes right (and here again, it seldom does), the tendrils of the fungus infiltrate the orchid seed and provide the nutrients that the developing embryo needs to grow. What does the fungus get out of the relationship? Don't be so sure it gets anything—these are orchids, after all.

GASPAR SILVERA is an orchid hunter and breeder in Panama given to wearing straw fedoras and married to a woman named Flor. An agronomist by training, Silvera has, since retiring from government service, devoted himself to rescuing orchids from the threat of development and to the painstaking work of propagating them. Photographer Christian Ziegler and I flew to his nursery in Chilibre after Silvera phoned us to report that one of his *Coryanthes*, the Central American bucket orchid, a species notoriously difficult to keep happy in captivity, had bloomed. We were hoping to witness one of nature's most dramatic PG-rated pollination scenes.

By the time we got to the nursery, the canary yellow flower, a surprisingly ungainly Rube Goldberg contraption, was already fading, though it still gave off a powerful perfume of apricots and eucalyptus. The flower had thrown open its elaborately engineered petals just a few days before, and the spicy-sweet perfume had summoned out of the surrounding woods a band of male euglossine bees, a sleek, stingless, iridescent relative of the bumblebee. The bees competed with one another for space on the slick curves of the intricately sculpted flower, directly above a labellum that forms a deep bucket, into which the flower drips a clear, slightly viscous liquid.

Nectar it is not.

Visiting bees busy themselves scraping fragrances from the waxy surface of the flower using their front legs; they then transfer the scents to tibia sacs carried on their rear legs like little wallets. Exactly what they're up to wasn't understood until 1966, when a botanist named Stefan Vogel figured out that the bees were collecting the chemical building blocks needed to create a scent. Most animals that rely on scents to attract a mate produce it themselves; not the euglossine bee, which forages for a specific set of ingredients, gathering them not only from orchids but also from certain leaves and fungi, and then mixes up the perfume by "hand." Once he's concocted his mixture, the bee spreads it on his body and flaps his wings to release a captivating scent of camphor and flowers to summon a female.

But the bucket orchid exacts a steep price for its contribution to this perfume. As the bees jostle each other for scents, one or more of them is apt to lose his footing on the slick petal and plunge into the bucket. This wouldn't be a problem, except the viscous liquid in the bucket renders the bee's wings temporarily useless. So the bee struggles mightily to clamber up the slippery walls of the bucket until he stumbles upon a series of steps, which conduct him up and out of the pool through a narrow passageway leading out the back of the flower. As the dazed and sopping bee squeezes himself through the tunnel, he passes beneath a spring-loaded device that (you guessed it!) claps a pair of yellow pollinia onto his back. If all goes according to (orchid) plan, the bee dries off his wings, flies to another *Coryanthes*, splashes into the bucket again, and on his way out through the tunnel unwittingly snags his yellow backpack on tiny hooks adapted for precisely that purpose. Pollination accomplished, the bucket orchid closes up shop, collapsing its extravagant petals into a wad of crumpled yellow tissue.

The case of the *Coryanthes* is a happy example of an orchid and its pollinator benefiting mutually, but such is not always the case. Although the euglossine bee escapes with his wallet full of scents, that's more than you can say

CORYANTHES PANAMENSIS: EUGLOSSINI SP. (BEE)

Lured into a bucket orchid, a euglossine bee escapes by wriggling out of a hatch fitted just for his species. Along the way, the unwitting insect picks up a pollen pack as a parting gift.

for some other orchids' hapless dupes. If it's starting to sound as though I don't trust orchids, that's because I've seen what they can do to some of my fellow animals. There's a video on YouTube, a riveting snippet of interspecies porn, in which you can watch a wasp be utterly bamboozled, and then humiliated, by an Australian tongue orchid. The tongue orchid *(Cryptostylis)* lures its pollinator by deploying a scent closely resembling the pheromone of the female wasp *(Lissopimpla excelsa)*. The male wasp alights on the tonguelike labellum, tail first, and commences to copulate with the flower, probing its interior with the tip of his abdomen until it bumps into the sticky pollinia, which attach themselves to the insect's posterior like a pair of yellow tails.

Having to play pin the tail on the pollinator is only the beginning of the wasp's humiliation. For with the tongue orchid we have passed beyond pseudocopulation into a realm even more perverse: More often than not, the wasp, in the throes of his misguided sexual exertions, actually ejaculates onto the flower.

Surely this represents the height of maladaptive behavior, and natural selection could be expected to deal harshly with a creature foolish enough to squander its genes having sex with a flower. ("Costly sperm wastage," is how the literature describes it.) That would be bad news for both the wasp and the orchid that depends on him. But as with so much else in the bizarre world of orchid sex, the matter is not quite so simple.

It appears that in some insect species, such as *Lissopimpla excelsa*, females can reproduce with or without sperm from a male. With it, they produce the usual ratio of male and female offspring; without sperm, they produce only male offspring. How convenient—for the tongue orchid, that is. By inducing wasps to waste their sperm on its flowers, tongue orchids are decreasing the amount of sperm available to

female wasps, thereby assuring themselves an even larger population of pollinators. Not only that, but the overabundance of male wasps increases competition for females, which makes the desperate wasps less picky in their choice of mates and that much more likely to fall for a flower.

What about the poor wasp? Why hasn't natural selection killed off an insect so dumb as to have sex with flowers? The best explanation I've heard is from John Alcock, who says that although the wasp may occasionally waste his genes on a plant, his "extreme sexual enthusiasm" is still a better reproductive strategy for an insect than being cautious about one's choice of mate. On balance, having sex with anything that moves yields more offspring, even if it also leads to occasional romantic disaster.

TO LEARN ALL THIS about orchids is to admire them more but, perhaps, love them less. And to wonder if we too have fallen prey to their deceptive charms. Like the scent-gathering euglossine bees, we use them to communicate our romantic intentions and lure mates, extracting their essence for perfumes and wearing them in corsages. Orchids have served us in this capacity since at least 1818, when William Cattley, an English plantsman, rescued a discarded orchid bulb that had been used as packing material in a shipment of tropical plants. The flowering of that specimen ignited a Victorian passion for orchids that has never really subsided.

The very name of the plant comes from the Greek word for testicle, referring not to the plant's flowers but its bulbs, organs that have long been endowed with aphrodisiac properties. But it doesn't take a Freudian to discern a strong sexual subtext in the passion for these flowers, especially among men, who any visit to an orchid show will tell you suffer disproportionately from "orchidelirium"—the Victorians' term for the madness these flowers inspire. Victorians were offended by the "blatant sexuality" of orchids, according to Eric Hansen, the author of *Orchid Fever;* he isn't referring to plant or insect sexuality either. "Prurient apparitions," is how Victorian critic John Ruskin described these flowers.

Prurient? Is it possible that humans can look at an orchid and, like the deluded orchid bees or male dupe wasps, see an apparition of female anatomy? (Georgia O'Keeffe certainly did.) Could it be that plant sex and animal sex have gotten their wires crossed in human brains just as they have among the bugs? That accident of evolution has proved another happy one for the orchid, for look how much we humans now do for these flowers: the prices paid, the risks to life and limb endured, the pains taken…

Those were my thoughts as I watched Gaspar Silvera deploy a pair of slender forceps to remove a pollinium from a bucket orchid that had failed to entrap a euglossine bee. ("I suppose you could say that I too am manipulated by orchids," he'd explained at the end of a shaggy tale about the lengths he goes to secure choice specimens.) Working with the steady hand of a jeweler, Silvera used the forceps to grab the base of the pollinium and then pressed it to a slit in the column of another bloom. Five years from now, Silvera may find himself with a precious new flower—and the orchid will have offspring it would otherwise not have had.

Ever since the first human-hybridized orchid bloomed (the earliest in the Western world was recorded in 1856), we humans have become important orchid pollinators too—more intentional perhaps than the orchid bees, but lured into advancing the orchid's interests just the same, assisting in its quest for world domination. Today there are some 100,000 registered hybrid orchids, most of them the offspring of improbable marriages among far-flung plants arranged by, and literally inconceivable without, us.

Not that any of this was ever in the orchid's plan. In evolution there is no plan, of course, only blind chance. But the moment that the orchid stumbled upon one of the keys to human desire and used it to unlock our hearts, it conquered a whole new world—our world—and enlisted a vast new crew of credulous animals more than happy to do its bidding. Let's face it: We're all orchid dupes now. □

ORCHIS PAPILIONACEA

To attract bees, this showy Sardinian orchid poses as a nectar-laden buffet, one of the "perfect contrivances" that amazed Charles Darwin—and that continue to fascinate us.

WHEN HENRY HUDSON FIRST LOOKED ON MANHATTAN IN 1609,

Turning back the clock four centuries, ecologists reveal how Manhattan Island appeared on the September afternoon Henry Hudson and his crew sailed into New York Harbor

1-22 COMPUTER-GENERATED IMAGE (TOP): MARKLEY/BOYER

WHAT DID HE SEE?

Before New York


TIMES SQUARE Long before it became
a symbol of Manhattan's hectic pace,
the intersection where Seventh Avenue
crosses Broadway (right) was once a
quieter place. Two creeks met here in a
red maple swamp and formed a beaver pond.
ART PHILIP STRAUB


LAUGH
FOSHISA
FOSHISA
CHEVROLET
Panasonic
SILVA-LEITES
LIDDELL
SHOGUN
APRIL 18
THE
LION
KING
Marriott
NO
TURN
NO
URNS

Of all the visitors to New York City in recent years, one of the most surprising was a beaver named José. No one knows

exactly where he came from. Speculation is he swam down the Bronx River from suburban Westchester County to the north. He just showed up one wintry morning in 2007 on a riverbank in the Bronx Zoo, where he gnawed down a few willow trees and built a lodge.

"If you'd asked me at the time what the chances were that there was a beaver in the Bronx, I'd have said zero," said Eric Sanderson, an ecologist at the Wildlife Conservation Society (WCS), headquartered at the Bronx Zoo. "There hasn't been a beaver in New York City in more than 200 years."

During the early 17th century, when the city was the Dutch village of New Amsterdam, beavers were widely hunted for their pelts, then fashionable in Europe. The fur trade grew into such a lucrative business that a pair of beavers earned a place on the city's official seal, where they remain today. The real animals vanished.

That's why Sanderson was skeptical when Stephen Sautner, a fellow employee at WCS, told him he'd seen evidence of a beaver during a walk along the river. It's probably just a muskrat, Sanderson thought. Muskrats are more tolerant of stressful city life. But when Sautner and he climbed around a chain-link fence separating the river from one of the zoo's parking lots, they found José's lodge right where Sautner had said it was. When they returned a couple of weeks later, they ran into José himself.

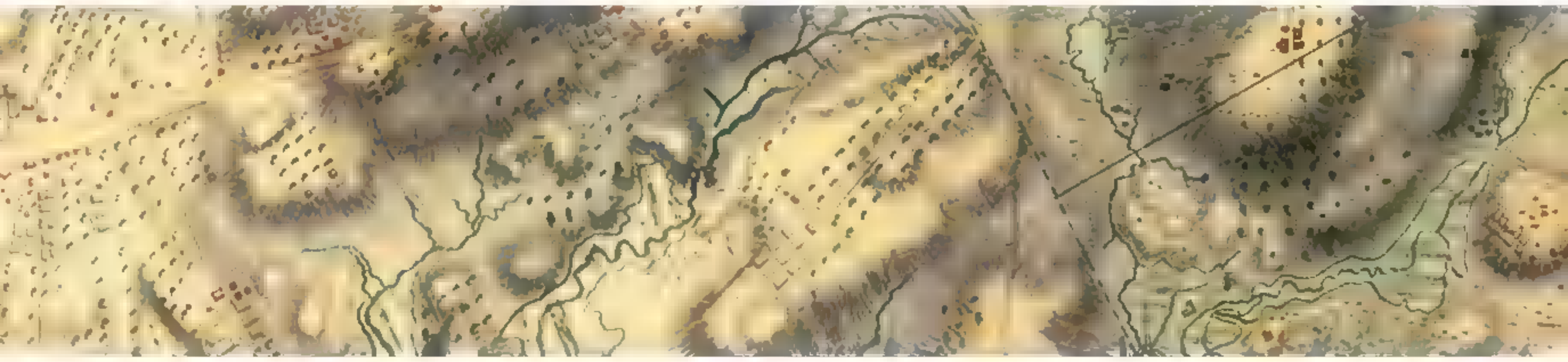
"It was just getting dark," Sanderson said. "We were standing on the riverbank shooting the breeze, when all of a sudden we saw the beaver. He swam right up to us, then he started doing circles in the river. We backed up a little, and he did that beaver alarm call with his tail, slap, slap against the water. So we decided we'd better take off."

The beaver's return to the Big Apple was hailed as a victory by conservationists and volunteers who'd spent more than three decades restoring the health of the Bronx River, once a dumping ground for abandoned cars and trash. José was named in honor of José E. Serrano, the congressman from the Bronx who'd pushed through more than $15 million in federal funds over the years to support the river cleanup.

For Sanderson, José's story meant something more. For almost a decade he has led a project at WCS to envision as precisely as possible what the island of Manhattan might have looked like before the city took root. The Mannahatta Project, as it's called (after the Lenape people's name for "island of many hills"), is an effort to turn back the clock to the afternoon of September 12, 1609, just before Henry Hudson and his crew sailed into New York Harbor and spotted the island. If people today could picture what a natural wonder Hudson had looked upon, Sanderson figured, maybe they'd fight harder to preserve other wild places. "I wanted people to fall in love with New York's original landscape,"

BY PETER MILLER
PHOTOGRAPHS BY ROBERT CLARK

ART BY MARKLEY BOYER
AND PHILIP STRAUB



A detail from an 18th-century map of Manhattan Island shows orchards and a farm on Murray Hill (at right).

he said. "I wanted to show how great nature can be when it's working, with all its parts, in a place that people normally don't think of as having any nature at all."

Long before its hills were bulldozed and its wetlands paved over, Manhattan was an extraordinary wilderness of towering chestnut, oak, and hickory trees, of salt marshes and grasslands with turkey, elk, and black bear—"as pleasant a land as one can tread upon," Hudson reported. Sandy beaches ran along stretches of both coasts on the narrow, 13-mile-long island, where the Lenape feasted on clams and oysters. More than 66 miles of streams flowed through Manhattan, and most of them sheltered a beaver or two—making José's appearance, in Sanderson's eyes, a rare glimpse of the way things used to be.

"You might find it difficult to imagine today, but 400 years ago there was a red maple swamp right here in Times Square," he said one day not long ago, as he waited for the light to cross Seventh Avenue. Dressed in black jeans and a Windbreaker, he didn't look much different from the tourists beside him on the curb. But unlike them, in his mind he was following a trail along a swampy creek that disappeared beneath the entrance to the Marriott Marquis Hotel at the corner of Broadway and West 46th Street. "Just over there was a beaver pond," he said, as a bus rumbled by. "It would have been a good place for deer, wood ducks, and all the other animals associated with streams. Brook trout probably, as well as eels, pickerel, and sunfish. It would have been much quieter, of course, although today's not so bad."

Sanderson conceived the Mannahatta Project one evening in 1999, after buying a coffee-table book of historical maps of the city. A recent transplant to New York from northern California, he was curious about how the city had evolved. "The landscape in Manhattan is so transformed, it makes you wonder what was here before," he said. "There are views in this city where you cannot see, except for a person or maybe a dog, another living thing. Not a tree or a plant. How did a place become like that?"

One map in particular caught his eye: a beautifully colored print from 1782 or 1783 that showed the hills, streams, and swamps as well as roads, orchards, and farms on the entire island—something no other contemporary map had done. More than ten feet long and three feet wide, the map had been created by British military cartographers during the eight-year occupation of New York during the American Revolution. Later called the "British Headquarters Map," it showed the island's topography in unusual detail because British officers needed that information to plan their defense of Manhattan. To Sanderson the map presented a unique opportunity to strip away the city's skyscrapers and asphalt and look at least partway back to the island's original landscape.

What would happen, he wondered, if he laid a street grid of today's city over this 18th-century rendering? Would anything line up? To find out, Sanderson enlisted family and friends, starting with his wife, Han-Yu Hung, and their young son, Everett, to join him on weekend expeditions to *(Continued on page 136)*

NATIONAL ARCHIVES, U.K.

Beneath New York

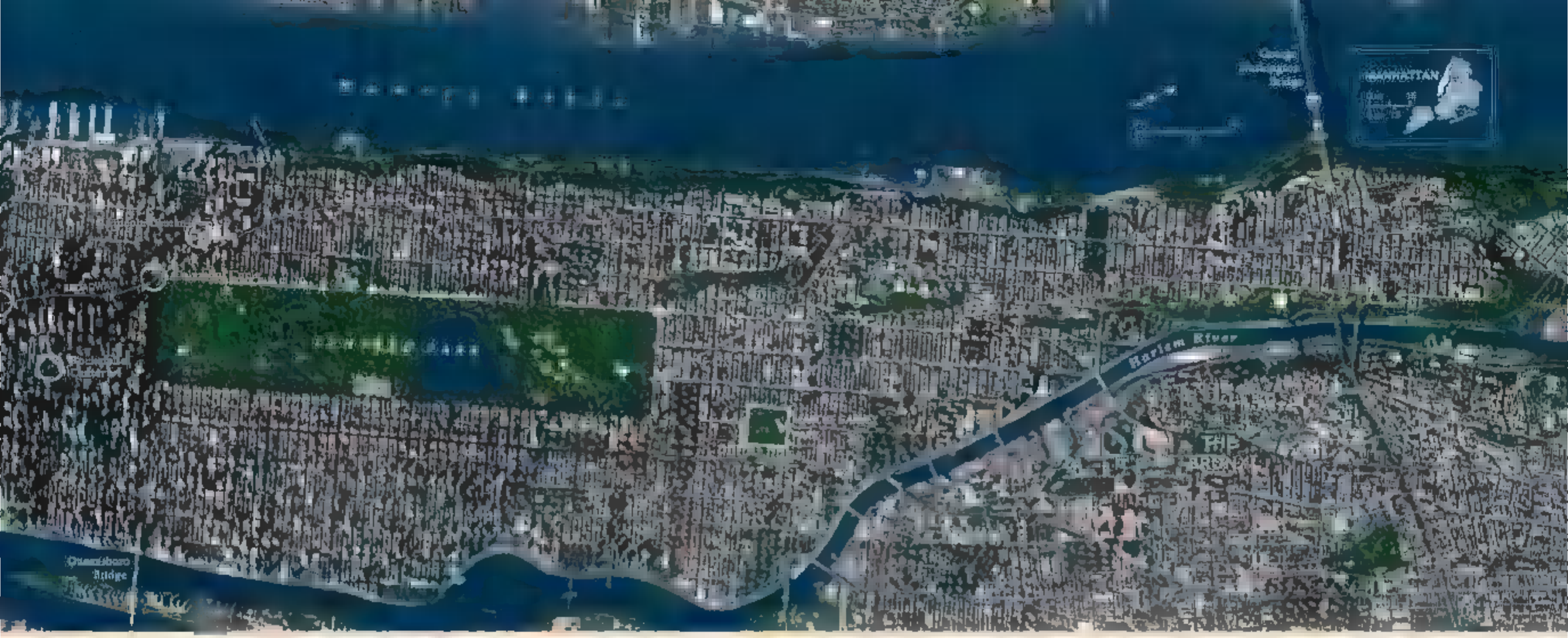
Late 18th-century shoreline of southern Manhattan (MAP BELOW)

TODAY

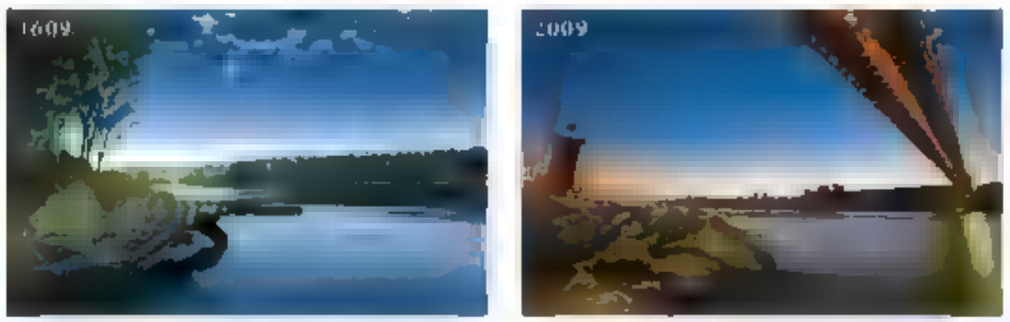
1782

Crafted by military cartographers during the American Revolution, the "British Headquarters Map" (below) depicts where streams once flowed and hills once stood. By comparing it with today's street grid (above), researchers have rediscovered, block by block, the island's original environment.

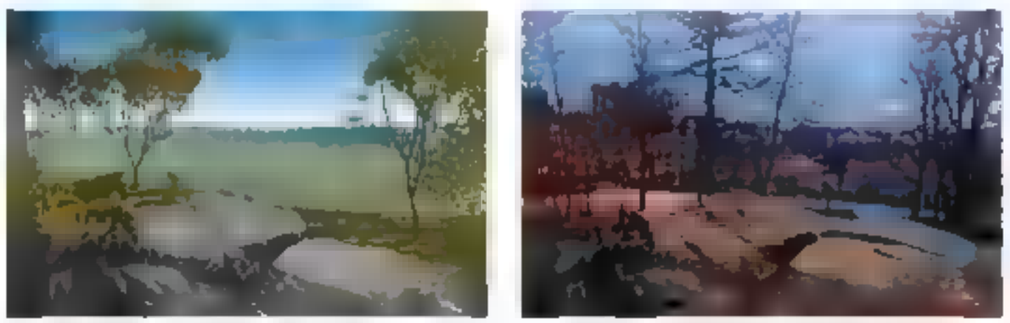
CAITLIN SARGENT; NGM MAPS. SATELLITE IMAGE (TOP): CNES, SPOT IMAGE. CIRCA 1782 MAP (BOTTOM): NATIONAL ARCHIVES, U.K.


MANHATTAN
Harlem River
Queensboro
Bridge

Manhattan was an extraordinary wilderness of towering chestnut, oak, and hickory trees, of salt marshes and grasslands with turkey, elk, and black bear.



HUDSON RIVER *Jeffrey's Hook, at the narrowest spot between Manhattan and New Jersey, was a crossing point for Native Americans centuries ago (left). Today the Little Red Light house, made famous by a children's book, stands beneath the George Washington Bridge.*



HARLEM PLAINS *The Lenape people may have used fire to keep open this grassy plain (left) for hunting deer and other game. The same bedrock that jutted through the ground in 1609 can still be seen today in Harlem's Marcus Garvey Park (right).*

COMPUTER-GENERATED IMAGES (LEFT, TOP AND BOTTOM) WARREN BEVER

FOLEY SQUARE *The Collect Pond*
[illegible] before
[illegible] main freshwater supply for
[illegible] Polluted by
[illegible] was buried under
slums later cleared to build the square.

Making Connections

Just as residents of Manhattan today rely on networks of goods and services, so did those on the island in 1609. A beaver, for example, needed a meandering stream and trees for food and shelter. The beaver, in turn, created a pond for fish and frogs. By tracing such relationships, researchers mapped out a network of likely species, called the Muir web (after naturalist John Muir), as depicted in this simplified chart (below).

What a Beaver Needs

Beavers need these elements to meet their habitat requirements.

Freshwater streams *provide water for . . .*

Ponds *provide food and water for . . .*

Freshwater marshes *provide water for . . .*

Streams, ponds, marshes, and other freshwater elements of the landscape depend on factors such as rainfall, topography, and groundwater.

American beech trees *provide food for . . .*

Birch trees *provide food for . . .*

Eastern cottonwoods *provide food for . . .*

Aspen trees *provide food for . . .*

Maple trees *provide food for . . .*

Box elder trees *provide food for . . .*

Willow trees *provide food for . . .*

Beavers are fond of trees near water, such as aspens or willows, which in turn depend on soil type, soil moisture, and other factors.

◀ TO THE REST OF THE MUIR WEB

Beavers

What Needs a Beaver

Beavers create habitat and serve as prey for other species.

1 A beaver builds a dam for shelter and a place to raise young.

Create . . .

Beaver dams, *which create . . .*

Beaver lodges, *which provide shelter for . . .*

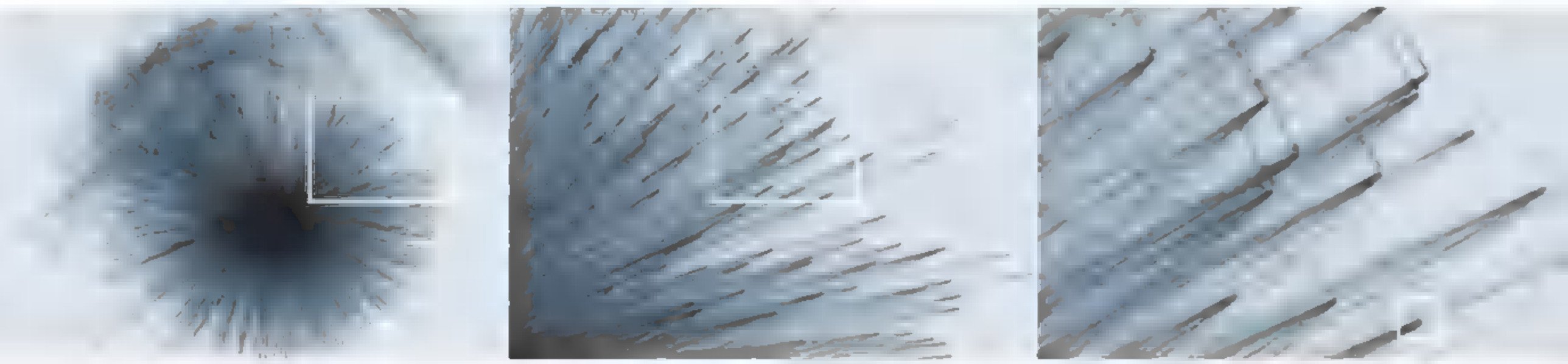
Are eaten by . . .

Mammals, *which provide food for . . .*

Mammals, *which leave behind . . .*

Medium-size predatory mammals include gray wolves, bobcats, and black bears.

HIRAM HENRIQUEZ, NG STAFF
ADAPTED FROM WILDLIFE CONSERVATION SOCIETY DATA



In this visualization of the entire Muir web of Mannahatta, beavers are only one of thousands of species and relationships.

2 The dam creates a beaver pond by blocking a slowly meandering stream.

3 The pond provides habitat for birds, insects, and fishes.

Beaver ponds, *which provide habitat for . . .*

Places near dams, *which provide shelter for . . .*

Eastern mud turtles, *which are eaten by . . .*

Northern water snakes, *which are eaten by . . .*

Among birds that eat insects are the American bittern, olive-sided flycatcher, and lesser yellowlegs as well as some sandpipers, warblers, and sparrows.

Fleas, *which are eaten by . . .*

Mosquitoes, *which are eaten by . . .*

Other insects, *which are eaten by . . .*

Flies, *which are eaten by . . .*

People, *who provide food and shelter for . . .*

Domestic dogs, *which are eaten by . . .*

Striped skunks, *which are eaten by . . .*

Common musk turtles, *which are eaten by . . .*

Carrion, *which provides food for . . .*

Blowflies, *which are eaten by . . .*

House flies, *which are eaten by . . .*

Dung beetles, *which are eaten by . . .*

Dung, *which provides food for . . .*

Scarab beetles, *which are eaten by . . .*

TO THE REST OF THE MUIR WEB ▶

(Continued from page 127) visit places on the map that still existed. Trinity Church in Lower Manhattan, for one, was founded in the late 17th century. A typical grave marker in the church cemetery reads, "Here Lyeth the Body of John Abrell Who Departed this Life Jan the 10th 1762 Aged 40 Years." Since the cemetery can be located on both the "British Headquarters Map" and today's street grid, Sanderson was able to push a virtual pin, so to speak, through both maps by taking a GPS reading at the site and attaching it to a digitized version of the older map. After repeating this process at 200 or so places, sticking in pin after pin, he and his team succeeded in matching the "British Headquarters Map" to today's city grid with an accuracy of half an uptown block, or roughly 130 feet. For Sanderson this added a whole new dimension to the modern city's landscape. He could now stand at any spot in Manhattan and picture, more or less, what had been there in 1782.

Take the gentle rise of Fifth Avenue as you walk past the New York Public Library. "There's a reason you can stand on the sidewalk here and see the tops of people's heads a few blocks away," Sanderson said. "This was near the top of Murray Hill, where the Murray family had a farm and orchard in 1782. During the battle for New York, the British landed at Kips Bay on the East River and marched up here, cutting off half of Washington's army, which was trapped in Lower Manhattan. There's a legend that Mrs. Murray offered tea to the British officers. So they stopped here at the farm, and while they were having tea, Washington's troops slipped past them on the Bloomingdale Road, which is now Broadway, and escaped."

As fascinating as the "British Headquarters Map" was, Sanderson didn't want to stop his time machine at 1782. He wanted to go all the way back to 1609. So he and his colleagues stripped from the map all the features that had been added by settlers and soldiers—such as roads, farms, and fortifications—until they'd reduced their digitized version of the map to the basic building blocks of the physical landscape: shorelines, hills, cliffs, land cover, streams, and ponds. As a landscape ecologist, Sanderson was used to taking apart wild places conceptually to understand how they work, separating a rain forest in Gabon, say, into geological, hydrological, ecological, and cultural layers. Now he and his colleagues set out to build a landscape from the bottom up, starting with the terrain and filling it with all the plants and animals that were likely to have lived there.

They began by listing the various ecosystems they could safely assume existed on the island, such as old-growth forests, wetlands, or plains, based on soil types, rainfall, and so on. Because it was located at the intersection of geographic regions, Manhattan probably had not only spruce trees from the northern forests but also magnolias from the southern forests, migratory birds from nearby flyways, and even tropical fish from the Gulf Stream during summer. In all, they identified 55 different ecological communities. "It was an incredibly diverse place," Sanderson said. "If the island had stayed the way it was back then, it could have become a national park like Yosemite or Yellowstone."

Once they identified the island's ecosystems, they could fill in the wildlife. But which animals lived where? To be as precise as possible, Sanderson's group took their research a step further. For each species they identified essential habitat requirements. A bog turtle, for example, needed a wet meadow, insects, and a sunny place to warm itself, while a bobcat needed rabbits and a den site in which to raise its young. "We just kept asking ourselves, What does this need? What does this need? What does this need?" Sanderson said. Then they compiled a list for each species. As they built their database, they discovered a dense network of relationships among species, habitats, and ecosystems on the island, not unlike the complex social networks that people create.

Peter Miller is a senior editor. Robert Clark's photographs of Angkor appeared in the July issue. This is the first time that work by Markley Boyer or Philip Straub has been published in the magazine.

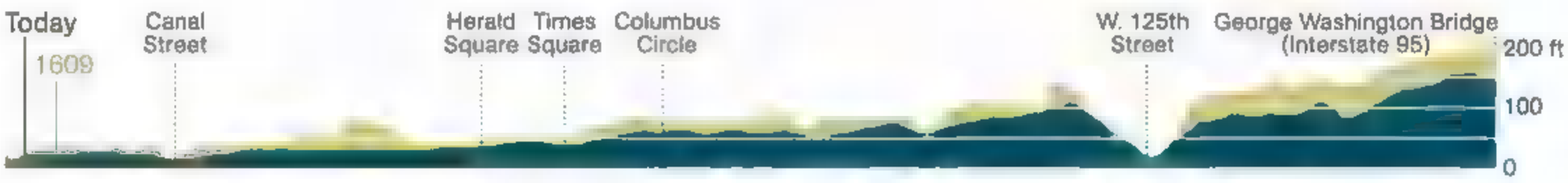
Sanderson called this network a Muir web, after American naturalist John Muir, who once noted that "when we try to pick out anything by itself we find that it is bound fast by a thousand invisible cords that cannot be broken, to everything in the universe." Sanderson and his team, in a sense, were trying to make those thousands of cords visible.

Consider a beaver that lived at Times Square in 1609. If you grabbed him by the scruff of his neck and lifted him out of the web, you'd find lines connecting him to a slowly meandering stream, to the aspen trees he ate, and to the mud and twigs he used to build a lodge. Not only that, you'd also find lines to the bobcats, bears, and wolves that depended on him as prey and to the frogs, fish, and aquatic plants that lived in the pond he helped to create. "The beaver, it turns out, is a landscape architect, just like people," Sanderson said. "You need him to flood the forest, which kills the trees that attract the woodpeckers that knock out cavities that wood ducks use for shelter." Lifting a beaver out of the web disrupts scores of other residents, which demonstrates how important it can be to think about an ecosystem as a network.

By the time Sanderson and his team had finished compiling their database, they'd put together one of the most detailed scientific reconstructions of a landscape ever attempted, identifying 1,300 or so species and at least 8,000 relationships linking them to one another and their habitats. This was somewhat ironic, Sanderson admitted, since it described a place that didn't exist anymore. But the same methods that created a portrait of Mannahatta could be applied to wild places today, such as the Greater Yellowstone region, the Congo forest, or the eastern steppes of Mongolia. If scientists have a model of how a landscape and species interact, they can better predict the impact of climate change, hunting, or other disruptive factors.

For the Mannahatta Project, the next step was to turn all of these data into realistic 3-D scenes, like the one you see at the top of page 122. Sanderson's goal, from the start, had been to show what any spot in today's city—say, the taxi stand on Seventh Avenue in front of Madison Square Garden—looked like 400 years ago. (It was a marsh at the edge of a forest.) To make that happen, Markley Boyer, a visualization specialist, used 3-D modeling software to populate each digitally created scene, block by block, with the right mix of oaks, hickories, streams, ponds, and marshes according to the Muir web database. "We're basically using the same kind of 3-D software they use in Hollywood to create digital armies marching across a plain," Boyer said, "only we're generating tens of thousands of trees in appropriate proportions for each forest type." Visitors to *themannahattaproject.org* can give the time machine a try by entering any address in Manhattan to see what that block looked like way back when.

As New Yorkers this month mark the 400th anniversary of Hudson's visit, Sanderson hopes his project, which has grown to include more than 50 historians, archaeologists, geographers, botanists, zoologists, illustrators, and conservationists from the WCS and other institutions, will stimulate a new curiosity about what existed on Manhattan before the explorer arrived. "I'd like every New Yorker to know that they live in a place that had this fabulous ecology," he said. "That New York isn't just a place of fabulous art, music, culture, and communications, but also a place of amazing natural potential—even if you have to look a little harder here." □



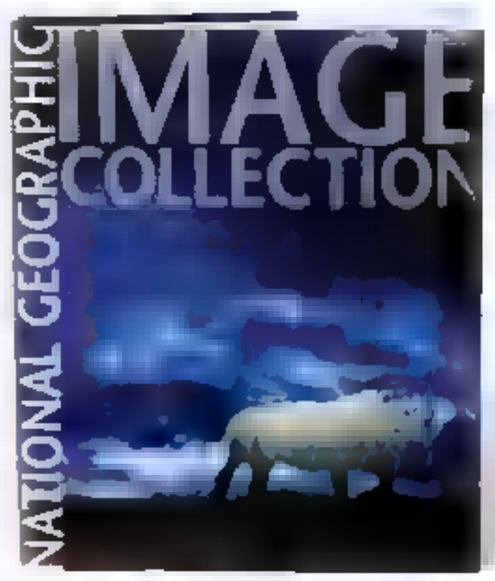
BULLDOZING BROADWAY A cross section of the island along the avenue shows how much of the landscape was leveled to build the city.

NGM MAPS

ON ASSIGNMENT **King Fever** Working for five months on ■ wet, windy island with the pervasive smell of penguin waste may sound like a nightmare, but it was Stefano Unterthiner's dream come true. As ■ child in Italy he'd seen a film about the southern Indian Ocean's Crozet archipelago and for years longed to document its wildlife. His chance came in December 2006 when he was sent there on assignment—his first for this magazine—to shoot this month's king penguins feature. Now, with his goal accomplished and more than 25,000 pictures to show for it, Unterthiner (above, on Possession Island) remains spellbound by the region: "I've never stopped wondering, and I've never stopped dreaming."

IN MEMORIAM **Bart McDowell** In 1974 in Soviet Georgia, Bart McDowell came to eat at ■ Tbilisi tavern—and left with gifts and a tale of dodging toasts to Stalin. He wove the story into one of five books (and more than 30 articles) he wrote in 32 years as a *Geographic* writer and editor. At the Vatican, subject of another book, he (left, at left) and photographer Jim Stanfield had remarkable access. Bart, who died this year, was a remarkable man. As a friend said, "He seemed incapable of writing ■ bad sentence."

Society Updates



NG BOOKS
Since 1890, when the first shot appeared in its pages, *National Geographic* magazine has been one of the world's leaders in photojournalism. Now 450 of its archival images—iconic and unpublished, color and black-and-white, human and wildlife wonders from every corner of the globe—are collected in one hardcover volume. *Image Collection* is available in bookstores October 13 ($50).

COLLECTOR'S EDITION
EarthPulse: State of the Earth 2010 is National Geographic's new visual almanac of global trends. Offering informative graphics and striking photography to provide an overview of the environmental issues shaping the 21st century, this special is available September 1 at bookstores and also at *nationalgeographic.com* ($10.99).

GeoPuzzle Answers

L	E	A	F	S	■	O	D	O	R	■	T	R	A	P
A	N	D	R	E	■	L	U	R	E	■	H	O	L	E
B	Y	D	E	C	E	1	T	O	F	■	E	D	I	T
S	A	S	S	■	T	O	Y	■	E	W	A	S	T	E
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A	N	A	T	■	T	R	I	A	D	■	H	E	R	O
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F	L	O	R	A	L	A	N	D	H	A	R	D	Y	■
■	■	■	I	L	L	S	■	■	U	N	I	■	■	■
M	A	D	D	E	R	■	■	U	M	■	T	1	E	S
A	R	I	D	■	O	N	E	S	P	L	A	N	T	S
T	E	A	L	■	A	A	R	E	■	E	G	G	O	N
H	A	Z	E	■	D	E	E	R	■	T	E	E	N	S

PHOTOS: STÉPHANIE UNTERTHINER (TOP LEFT); CHARLES KOGOD (BOTTOM LEFT)

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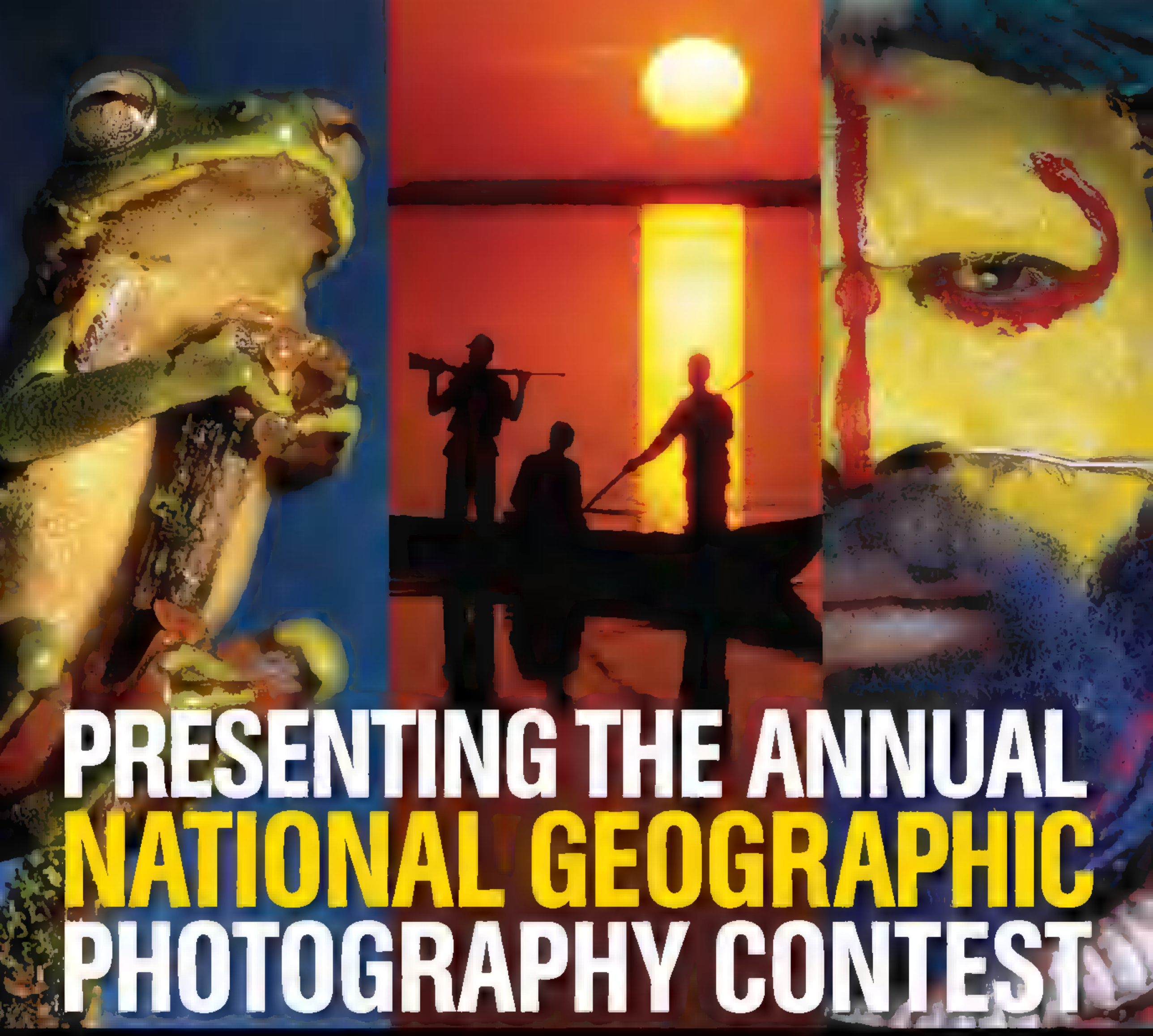

PRESENTING THE ANNUAL NATIONAL GEOGRAPHIC PHOTOGRAPHY CONTEST

As a leader in capturing our world through brilliant imagery, *National Geographic* magazine sets the standard for photographic excellence. Once again we're inviting you to share your vision of the world through your own photography.

Submit your entry online in any of these three categories:

PEOPLE

PLACES

NATURE

Enter to win and you could find your photograph published in the pages of *National Geographic* magazine!

Hurry, contest ends October 31, 2009.

For more details, complete rules and regulations, and information on how you can enter today, visit *ngphotocontest.com.*

NATIONAL GEOGRAPHIC MAGAZINE

John-Joseph van Haelewyn

John and Shirley Spinelli included National Geographic in their estate plans.

Support the Future

"We believe in the work of National Geographic and wanted to be involved," says John Spinelli. He and his wife Shirley grew up reading *National Geographic* magazine and passed that love on to their children and grandchildren. Now retired, they enjoy in-line skating, tennis and bird watching.

The Spinellis set up a charitable gift annuity which provides them with steady income and tax savings while supporting the Society's efforts worldwide. "National Geographic is an important source for solutions to the challenges facing our planet," says John. "We want the world to be in good shape for our grandchildren."

For more information about a charitable gift annuity or other ways to include National Geographic in your estate plans, please contact the Office of Estate Planning.

Sample Annuity Rates for One Beneficiary

(rates at other ages available upon request)

Age 65 = 5.3% Age 75 = 6.3% Age 85 = 8.1%

Rates are subject to change and Charitable Gift Annuities may not be available in every state. Please call for current rates and availability.

NATIONAL GEOGRAPHIC

Office of Estate Planning
1145 17th Street NW
Washington, DC 20036

(800) 226 - 4438
plannedgiftinfo@ngs.org
www.nationalgeographic.org/donate

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Address _____

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Mail to: National Geographic Office of Estate Planning
1145 17th Street NW, Washington, DC 20036

FLASHBACK

Smoking Hot Sunlight focused on ■ reflective disk bounces back enough heat to light ■ cigarette in Phoenix, Arizona. This solar-cooker demonstration, part of the World Symposium on Applied Solar Energy, was one of 85 displays from 50 exhibitors on the grounds of the Phoenix Public Library in the fall of 1955. Some 29,000 people came to marvel at sun-powered sights, from electricity generation to furnaces to baking cinnamon rolls. But the Cold War may have prevented ■ warm welcome for visiting Russian solar scientists. "The Soviet exhibit created a few questions," note the photographer's captions. "There appeared neither the scheduled exhibit or exhibitor." *—Margaret G. Zackowitz*

Flashback Archive Find all the photos at **ngm.com.**

PHOTO: BOB TOWERS, NATIONAL GEOGRAPHIC STOCK

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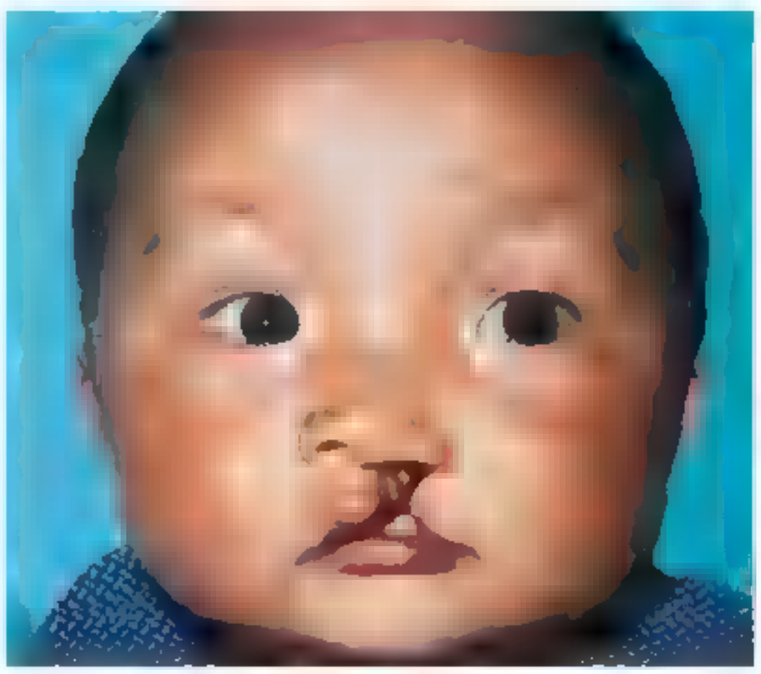
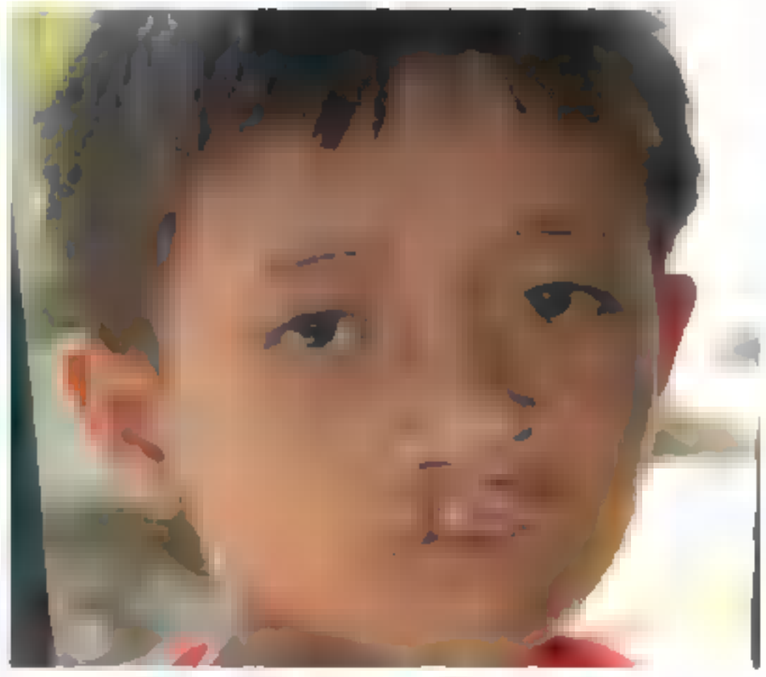
Each Of These Kids Needs Somebody Who Cares Enough To Send $250. Once.



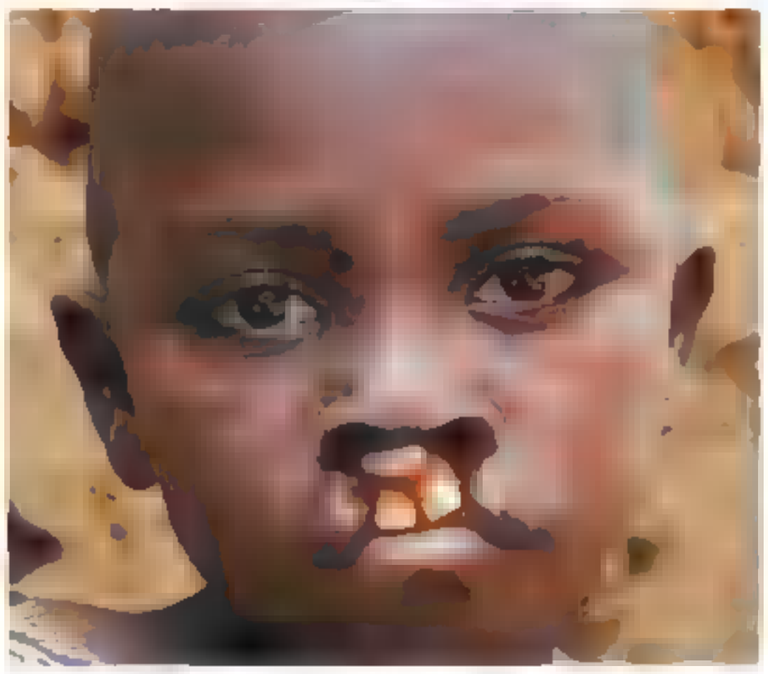
Ming, 6 months, China

Shiva, 1 year, India



Mot, 13 years, Cambodia

Durgap, 5 years, India



Funmi, 8 years, Nigeria

Salazar, 5 years, Philippines

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world beat

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For more information, visit *usmint.gov/timeless*.

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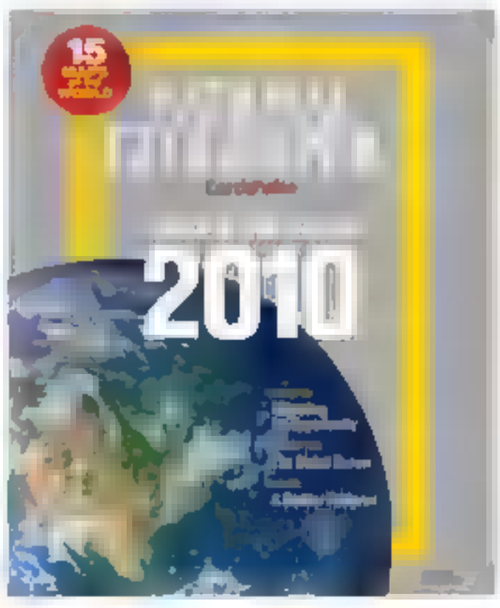

EarthPulse: State of the Earth 2010 special collector's edition uses dynamic photography, maps, graphs, and analysis to examine the crucial trends transforming our planet. Our future depends on understanding these trends and gaining true perspective on the possibilities that lie ahead.

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Visit *earthpulse.nationalgeographic.com* for more information.

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Legal Notice

If You Are a Licensed Driver or Own a Motor Vehicle A Proposed Class Action Settlement May Affect Your Rights

Para Una Notificación En Español, Llame O Visite Nuestro Website www.dppasettlement2.com

There is a Proposed Settlement in a class action lawsuit, *Fresco*, et al. *v. R.L. Polk & Co. and Acxiom Corp.*, Case No. 07-cv-60695-JEM, in the U.S. District Court for the Southern District of Florida.

The Proposed Settlement affects a "Class," or group, of people that may include you. This is just a summary of your rights. To get complete information you should visit www.dppasettlement2.com or call 1-866-397-0925.

What Is the Case About?

The people who filed this lawsuit, the Plaintiffs, claim that the Defendants knowingly obtained, used, or disclosed personal information from motor vehicle records in violation of a federal law, the Driver's Privacy Protection Act ("DPPA").

The companies that were sued, the Defendants, don't think they did anything wrong. They agreed to the Proposed Settlement to avoid the further expense, inconvenience, and burden of this litigation.

Who Is Involved?

The Class includes all persons whose Personal Information or Highly Restricted Personal Information (as those terms are defined by the DPPA) was obtained, used or disclosed by either of the Defendants from April 1, 1998 through the date that the Court approves the Final Order.

The Defendants are: R.L. Polk & Co. and Acxiom Corporation.

What Does the Settlement Provide?

The relief provided is injunctive. This means that the Defendants have agreed to design, implement, and maintain specific, substantial procedures to enhance compliance with the DPPA when they obtain, use, or disclose information regulated by the DPPA. There will be no monetary recovery for Class Members. However, if you have actual money damages, you can file a lawsuit on your own.

Who Represents Me?

The Court has appointed attorneys to represent the Class. Class Counsel will request that the Court award attorneys' fees and expenses in an amount not to exceed $7.5 million. You may hire your own attorney, if you wish. However, you will be responsible for your attorney's fees and expenses.

What Are My Legal Rights?

If the Court approves the Proposed Settlement, you will be bound by the Court's decisions. You will not be able to sue the Defendants for the claims that were made in this lawsuit, including claims for statutory liquidated damages. But you will be able to sue for actual money damages in an individual lawsuit. For full information about the rights you are giving up, please read the *Notice of Proposed Class Action Settlement*.

You Can Tell the Court if You Do Not Like the Proposed Settlement.

To object or comment, you must send a letter that is mailed and postmarked no later than October 9, 2009, as outlined in the *Notice of Proposed Class Action Settlement*. If you employ a lawyer to prepare the objection, then the objection letter must include a section detailing the lawyer's experience with class actions. The section must specifically list the capacity in which the lawyer participated in each class case (*e.g.* plaintiffs', defendants', or objectors' counsel) and the outcome of each class case. If the lawyer represented objectors in a class case, then the lawyer must detail the disposition or effect that the objection had on each class case. Please note that even if you employ a lawyer to prepare the objection, you must still personally sign the objection letter. By signing the objection letter, you are attesting that you discussed the objection with the lawyer and have fully reviewed the objection letter.

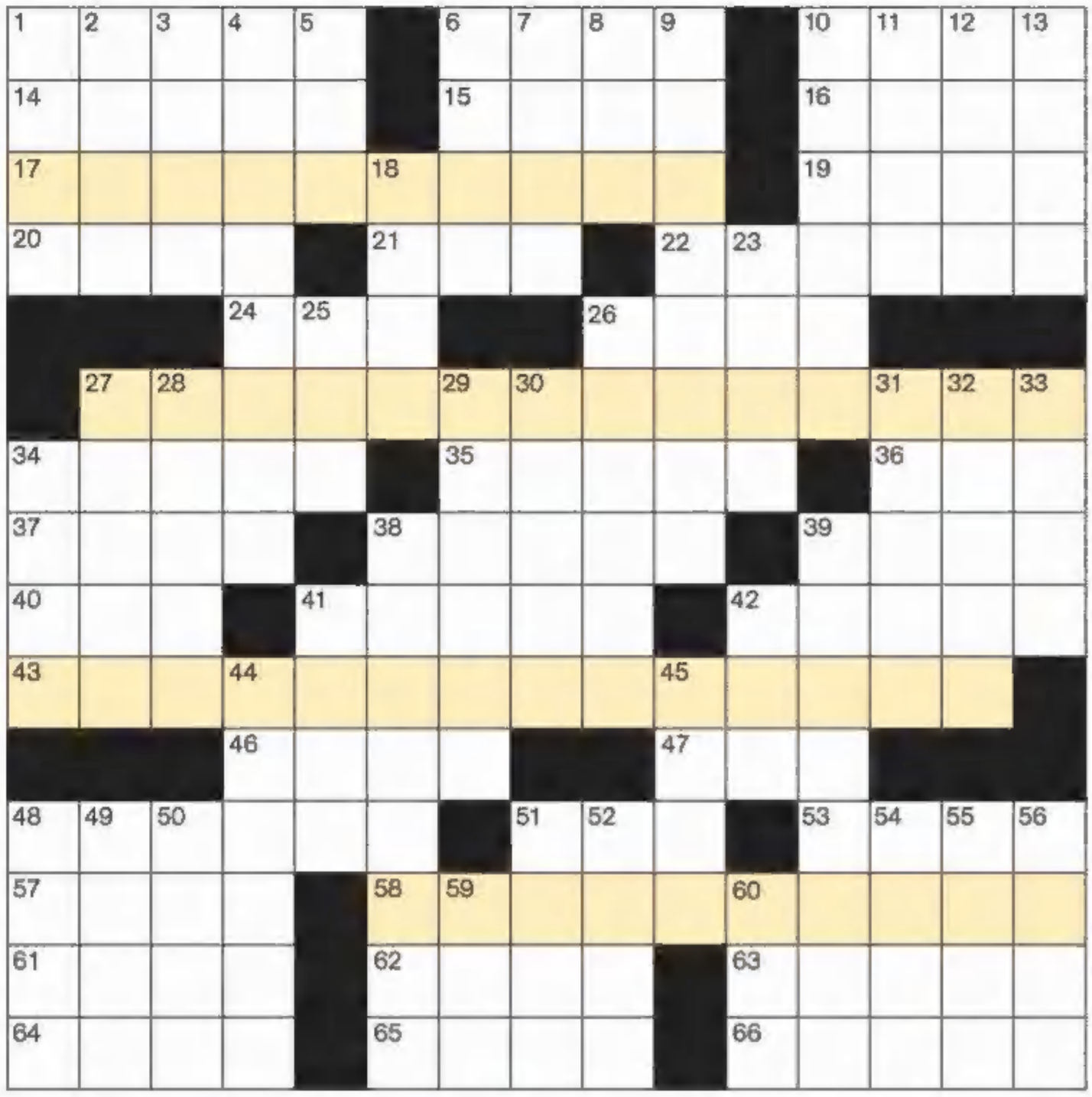
Will the Court Approve the Proposed Settlement?

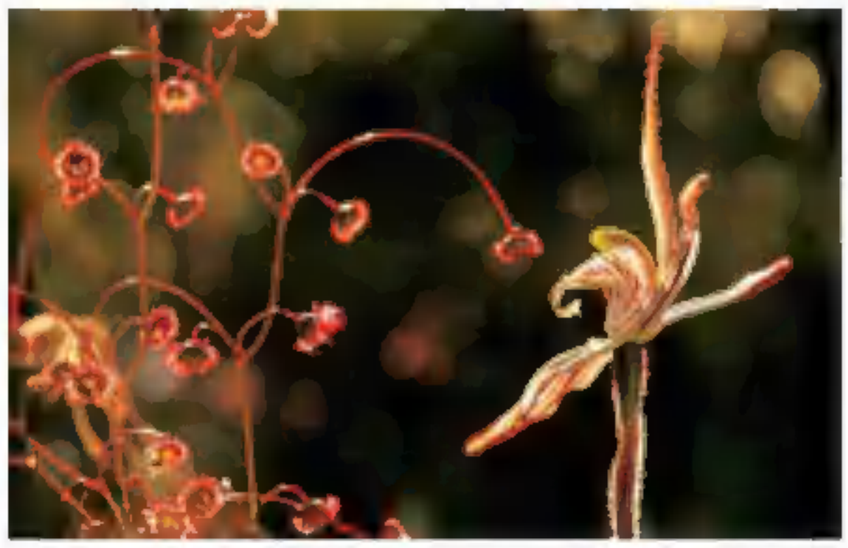
The Court will hold a Final Approval Hearing on December 7, 2009 at 10:00 a.m. to consider whether the Proposed Settlement is fair, reasonable, and adequate and to consider the motion for attorneys' fees and expenses. If comments or objections have been received, the Court will consider them at this time.

For more information on the Proposed Settlement, and to get a copy of the *Notice of Proposed Class Action Settlement*, call 1-866-397-0925, visit www.dppasettlement2.com, or write DPPA Settlement Administrator, c/o The Garden City Group, Inc., P.O. Box 9000, #6520, Merrick, NY 11566-9000.

1-866-397-0925
www.dppasettlement2.com

GEOPUZZLE





Wily Orchids

Puzzle by Cathy Allis

Orchids and crossword puzzles have something in common. Both practice trickery. The story on page 100 looks at the games orchids play with their pollinators. Tinted puzzle clues have a little fun with the flimflamming flowers.

ACROSS

1 Riffles (through)
6 *Dracula* orchid's emission
10 Bucket orchid's bucket, to male euglossine bees
14 Musical Previn or Watts
15 Star orchid of Madagascar's nectar, to a hawk moth
16 Pore
17 With 58 Across, how many an orchid's pollen sac ends up "flying"?
19 Computer menu heading
20 Verbal disrespect
21 Product of Santa's workshop
22 High-tech trash
24 Saharan
26 Income sources for sr. folk
27 Get a pollen sac stuck to oneself, à la orchid bee?
34 French author of *The Plague*
35 Passageway for a stray
36 Marauder of yore
37 Subj. in which you learn your parts
38 Chord such as C-E-G
39 Horizontal kin of a Dagwood
40 Chicken or chair piece
41 Memento
42 Organ with a beat
43 Like orchids, thanks to natural selection?
46 Societal troubles
47 Prefix with cellular
48 More furious
51 __ arabic (acacia tree output)
53 Marks on some scores, or some scores
57 Suitable for cacti, climatewise
58 See 17 Across
61 Duck or color
62 Bern's river
63 Goad
64 Azure obscurer
65 Does in forests?
66 Youth group

DOWN

1 Chem class sites
2 Celtic one-name singer
3 Does sum work
4 Kind of orchid corsage that lasts longest
5 1/3600 of an hr.
6 Miscellany
7 Import tax
8 Gold, at the Alhambra
9 Was a court judge?
10 Daddy Warbucks's right-hand man
11 Low-light retinal receptors
12 Landed
13 Rose in Reds history
18 Latin words to an assassin
23 Like the surface of a bucket orchid
25 Authorizes
26 Manhattan is one
27 Solar __ (rooftop heat absorber)
28 Insect's adult stage
29 Anoraks and such
30 Like the Coneheads
31 In the lead
32 Spicy mixture in Indian dishes
33 Massage target
34 Young yak
38 Turnpike
39 Birthright
41 It may be tall
42 Chinese dynasty after the Qin
44 Form of brainteaser
45 A dromedary has one
48 Geometry, algebra, and trig
49 Geometry calculation
50 Mexican dictator Porfirio __
51 Actor Richard, Tibet activist
52 Pusher's customer
54 Pulitzer-winning playwright for *Picnic*
55 School founded by Henry VI
56 Nine-digit IDs
59 Robert Burns denial
60 Tennis call

Answers in Inside Geographic

PHOTO: CHRISTIAN ZIEGLER

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